

DRAFT

Nongroundwater Remedial Investigation Report



Reynolds Metals Company
TROUTDALE FACILITY

CH2MHILL

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Abbreviations and Acronyms

AOU	area of uncertainty
bgs	below ground surface
BLA	Blue Lake Aquifer
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CL	Company Lake
cm/sec	centimeters per second
CN	cyanide
COE	U.S. Army Corps of Engineers
COP	City of Portland
cPAH	carcinogenic polynuclear aromatic hydrocarbons
CSS	<i>Current Situation Summary</i>
Cu	copper
CU1	Confining Unit 1
CU2	Confining Unit 2
D	diluted
DCE	dichloroethene
DEQ	Oregon Department of Environmental Quality
EE/CA	Engineering Evaluation/Co st Analysis
EM	electromagnetometer
EPA	U.S. Environmental Protection Agency
ESP	electrostatic precipitator
F	fluoride
FF	flood fringe
FS	feasibility study
ft/ft	feet per foot
ft/sec	feet per second
GI	gastrointestinal
gpd	gallons per day
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GS&G	Gresham Sand and Gravel
HEPA	high-efficiency particulate air
Hg	mercury
HM	heavy manufacturing
J	estimated
lb/day	pound per day
LNAPL	light non-aqueous-phase liquid
MCC	Multnomah County Code
MCL	maximum contaminant level
MF	mixing factor

mgd	million gallons per day
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
Mn	manganese
MSL	mean sea level
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetland Inventory
ODEQ	Oregon Department of Environmental Quality
ORS	Oregon Revised Statute
OWRD	Oregon Water Resources Department
P	Data qualifier used for PCB analytes
PAH	polynuclear aromatic hydrocarbon
PCB	polycyclic biphenyl
PCE	tetrachlorethene
PWB	Portland Water Bureau
RD/RA	remedial design/remedial action
RI	remedial investigation
RMC	Reynolds Metals Company
ROD	Record of Decision
RPM	Robertson's Protected Metal
RSA	removal site assessment
SAP	<i>Sampling and Analysis Plan</i>
SDA	<i>Draft Soil and Debris Areas Addendum to the RI/FS Work Plan</i>
SEC	significant environmental concern
SVOC	semivolatile organic compound
SWLA	<i>Draft South Wetlands Addendum to the RI/FS Work Plan</i>
TCLP	toxicity characteristic leaching procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TPH-D	total petroleum hydrocarbons for diesel
TSA	Troutdale Sandstone Aquifer
TSP	trisodium phosphate
TSS	total suspended solids
U	undetected
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	vanadium
VOC	volatile organic compound

Executive Summary

Executive Summary

Introduction

- The site remedial investigation (RI) for the Reynolds Metals Company (RMC) facility in Troutdale, Oregon, was conducted in four related programs:
 - Soil and debris areas
 - Wastewater discharge areas
 - Surface water and sediment areas
 - Sitewide groundwater
- This document summarizes the results of site investigations from 1994 to 1999 for all environmental media other than groundwater. The results for groundwater are presented in the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999).
- The significance of the investigation results are assessed in the *Draft Baseline Risk Assessment, Part 1—Nongroundwater Media* (CH2M HILL, May 1999), and the potential need for a remedial response is evaluated in the Focused Feasibility Study, currently in development.
- All of the information presented in this document has been previously submitted to the U.S. Environmental Agency (EPA) and the Oregon Department of Environmental Quality (DEQ). This document briefly summarizes the information and directs the reader to previous documents containing more detailed presentations.

Sitewide Physical Setting

- The RMC facility is a primary aluminum reduction plant located at the confluence of the Columbia and Sandy Rivers. See Figure ES-1.
- A U.S. Army Corps of Engineers (COE) flood control dike runs east-west through the northern portion of the RMC property. North of the dike, the site is within the 100-year floodplain, and portions are within the 10-year flood plain.
- The RMC property south of the flood control dike is currently zoned Urban Future (UF-20) and Urban Heavy Manufacturing (HM). North of the dike the property is zoned UF-20, with overlays for Significant Environmental Concern (SEC) and Flood Fringe (FF).

Plant and Project History

- The plant was constructed for the U.S. Government in 1941. RMC leased the plant from the government in 1946 and purchased it in 1949.
- The site was placed on the National Priorities List by EPA in 1994, making it a "superfund" site, and in 1995 RMC began a formal remedial investigation and feasibility study (RI/FS) process.

- Based on past operations, samples were collected from surface and subsurface soils, surface water, sediment, and groundwater.
- From a general list of constituents, as the project proceeded, a shorter list was developed in collaboration with EPA and DEQ. Preliminary risk assessments, based on actual detections and reasonably expected exposures, were used to focus the investigation on the important constituents.

Soil and Debris Areas

- Ten soil and debris areas were identified for investigation at the site:
 - East potliner
 - Cryolite ponds
 - Bakehouse sumps
 - Polychlorinated biphenyl (PCB) spill area
 - Scrap yard
 - North landfill
 - South landfill
 - Fairview Farms
 - Mineral oil spill area
 - South wetlands

Early Actions in the Soil and Debris Areas

- Of the ten soil and debris areas identified, four were selected for early action to reduce potential risk without waiting for the RI/FS to be completed.
- These early actions were:
 - East potliner: removal of over 11,000 tons of spent potliner and other waste material
 - Cryolite ponds: removal of nearly 14,000 tons of waste and fluoride-contaminated soil
 - Bakehouse sumps area: well point abandonment; sump cleaning, soil removal, reconstruction; electrostatic precipitator (ESP) system improvements
 - PCB spill area: removal of PCB-contaminated soil from outside casthouse
- In addition to actions completed in the soil and debris areas, early actions were also taken to:
 - Dredge the South Ditch forebay
 - Remove soil from the diesel spill area
 - Improve sitewide access restrictions
 - Decommission nine production wells no longer in use

- Remove PCB-contaminated dust from inside the casthouse and casthouse siding containing PCBs and asbestos
- Remove debris piles from Fairview Farms

Scrap Yard

- Scrap yard is a flat area east of the bakehouse and within the plant fence. Scrap yard was formerly used for raw material storage and is currently used for storage of debris and other manufacturing products.
- Constituents investigated and detected at scrap yard include fluoride, cyanide, polynuclear aromatic hydrocarbons (PAHs), PCBs, and metals.
- Rainfall infiltration and leaching of constituents from surface soils and deposits are the most likely mechanisms for transport of constituents to groundwater. PAHs and PCBs do not readily migrate and do not appear to have been transported to groundwater.

North Landfill

- North landfill, located north of the dike, was active from about 1965 to about 1985.
- The waste materials in north landfill include carbon waste, refractory brick, solid waste, demolition waste, and miscellaneous debris.
- Constituents detected at north landfill include fluoride, cyanide, PAHs, PCBs, and metals.
- Leaching of some constituents from primary source materials to groundwater appears to have occurred at north landfill.
- The water table at north landfill varies seasonally and across the site; typically it is between approximately 10 and 15 feet below ground surface (bgs). During the high water season, some of the waste is within shallow groundwater.
- PAHs and PCBs do not readily migrate and do not appear to have been transported to groundwater.

South Landfill

- South landfill, located south of the main plant, was used for general waste disposal from the early days of plant operation until the late 1960s, and for temporary storage into the 1970s.
- Constituents detected in soils at south landfill include fluoride, cyanide PAHs, PCBs, and metals.
- Surface water sampled in a shallow swale just south of south landfill contained fluoride, cyanide, and metals.
- The water table in this area of the site is shallow and some of the waste in south landfill is in contact with groundwater for some or all of the year.

- PAHs and PCBs do not readily migrate and do not appear to have been transported to groundwater.

Fairview Farms

- Fairview Farms is a 222-acre fenced area located west of the main plant, across Sundial Road.
- Fairview Farms was investigated because it might have been affected by the operations at the RMC facility through various routes of constituent transport, including airborne deposition, transport by surface waters, and deposition of debris from plant production. It was also believed to be downgradient of groundwater at the plant.
- Constituents detected in soils and dredge spoils include low levels of fluoride, metals, and PAHs.
- Constituent concentrations detected in soil samples taken under the dredge spoils and debris piles did not appear to be significantly higher than concentrations detected in surface soil samples, suggesting that leaching of constituents has been minimal.
- The debris piles were removed from Fairview Farms in an early action.

Mineral Oil Spill Area

- The mineral oil spill area is in the north portion of the main plant area. Three oil storage tanks are located in this area.
- Two separate spills are believed to have occurred in the area.
- Although the storage tanks were never used to store "PCB oil" (containing PCB concentrations greater than 50 mg/L), they may have contained oil inadvertently contaminated with PCBs from other equipment.
- PCB concentrations in the investigated area ranged from less than 0.3 mg/kg to 2.1 mg/kg below the EPA recommended cleanup levels of 10 to 25 parts per million (ppm) for industrial settings (*EPA Guidance on Remedial Action for Superfund Sites with PCB Contamination*. OSWER Directive No. 9355.04-01, EPA, 1990).
- Groundwater in this area does not appear to be threatened by the release of either the oil or the PCB content.

South Wetlands

- South wetlands is a 23-acre area south of the plant, which includes the Building 97 subarea and West Drainage. The main wetland area supports wetland-type plants such as reed canarygrass.
- South wetlands was used as a settling pond for wastewater discharges from the plant between 1941 and 1965, when plant discharges were diverted to Company Lake.
- The primary source of constituents is a layer of process residue deposited from past wastewater discharges.

- Constituents detected at elevated levels include fluoride, cyanide, PAHs, PCBs, and metals.
- The distribution of cyanide appears to be random; the distribution of the other constituents supports the current understanding that the source of elevated constituents in south wetlands is past wastewater/stormwater discharges along the northern and eastern boundaries.
- Leaching of constituents from the process residue is the most likely mechanism for transport of dissolved constituents to subsurface soil, surface water, and shallow groundwater.
- Surface water monitoring in Salmon Creek above and below the confluence with West Drainage did not show consistently higher constituent concentrations in the downstream samples.

Wastewater Discharge Areas

South Ditch

- South Ditch is a manmade ditch which flows east to west along the south side of the main plant and serves as the primary surface water drainage feature for the RMC facility.
- The eastern end of the ditch turns north and drains the east potliner area and open land to the north.
- The eastern portion of the ditch receives primarily surface water runoff; the western portion also receives permitted process water and wastewater and is part of the facility's permitted National Pollutant Discharge Elimination System (NPDES). Both portions receive shallow groundwater in the wet season and discharge to groundwater in the dry season.
- In East South Ditch and West South Ditch, elevated constituents detected in sediment include fluoride, cyanide, PAHs, and metals. With the exception of PAHs, these constituents were also detected in surface water in East South Ditch and West South Ditch.

Company Lake

- Company Lake, located north of the COE dike, covers approximately 14 acres in area and is used as a permitted wastewater treatment pond.
- Influent flows are pumped from South Ditch and an outfall ditch connects Company Lake to the Columbia River.
- A depression east of the outfall ditch may receive wastewater discharges when river levels are high and was investigated. Elevated levels of fluoride and PAHs were detected in the soil in the depression.
- A layer of process residue from a discontinued plant operation covers most of the bottom of Company Lake.

- Constituents detected in the process residue are consistent with those in the permitted waste streams: fluoride, metals, PAHs, and total petroleum hydrocarbon (TPH). Relatively low concentrations of cyanide and PCBs were detected in some process residue samples.
- Brick from the bakehouse pits cover the north face of the COE dike adjacent to Company Lake and were investigated for their leaching potential to the pond. Sampling at Company Lake and testing of the brick both indicate that the brick has not been a major contributor of constituents to Company Lake.
- Fluoride is believed to migrate from the process residue in Company Lake to groundwater at a concentration of approximately 20 mg/L.

Surface Water and Sediment Areas

Four surface water and sediment areas were investigated:

- Columbia River
- Sandy River
- Salmon Creek
- East Lake

Columbia and Sandy Rivers

- The Columbia and Sandy Rivers represent local and regional groundwater discharge zones.
- Both rivers support significant fisheries.
- The reaches of both rivers adjacent to the RMC facility are areas of high disturbance and do not have an abundance or diversity of benthic invertebrates. These disturbances are both natural and manmade: the Sandy River has a dynamic delta of shifting sandbars, and intentional dredging of this deposited sand is conducted in the Columbia River, just downstream of the Sandy River mouth.
- Bakehouse brick has been deposited on relatively short stretches of the banks of both rivers but has not contributed significant amounts of constituents to either river.
- Groundwater containing fluoride at elevated concentrations appears to be discharging to the rivers at localized areas of the facility. However, conservative estimates of the amount of fluoride entering the rivers indicate that the increase in concentration for the Columbia River would be on the order of 0.00005 mg/L and for the Sandy River 0.006 mg/L. These concentrations are below the standard analytical detection limits.

Salmon Creek

- Salmon Creek flows along a section of the southwest border of the RMC site near south wetlands.
- Salmon Creek serves as stormwater conveyance for part of the City of Troutdale, the City of Wood Village, and the City of Fairview. Salmon Creek water quality is affected

by urban, industrial, and Troutdale Airport stormwater as well as groundwater and past and current discharges from RMC.

- Fluoride was detected downstream of West Drainage; no cyanide was detected upstream but was detected in one downstream sediment sample; PAHs and PCBs were detected both upstream and downstream.

East Lake

- East Lake is a shallow lake north of the COE dike, without inlets or outlets and surrounded by Himalayan blackberries.
- East Lake surface water and sediment were sampled twice. No cyanide, PAHs, or PCBs were detected in surface water. No cyanide or PCBs were detected in sediment. PAHs were detected both times in sediments.
- East Lake does not pose a threat to surface water or groundwater.

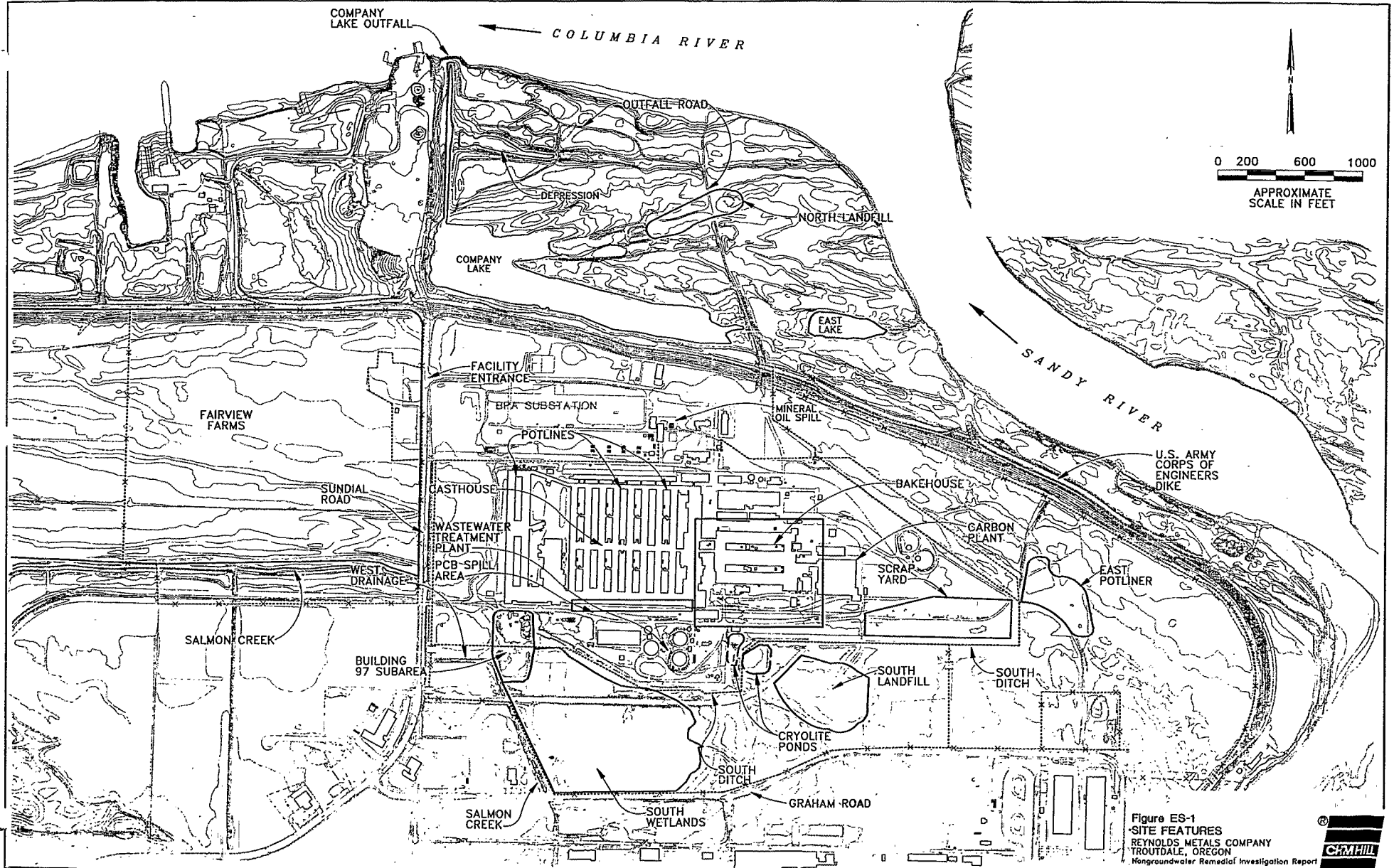


Figure ES-1
SITE FEATURES
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report



SECTION 1

Introduction

The remedial investigation and feasibility study (RI/FS) for the Reynolds Metals Company (RMC) facility at Troutdale, Oregon, has been conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The purpose of the remedial investigation was to collect sufficient data to determine (in the baseline risk assessment) whether remedial action was needed, and if so, to support the development and evaluation of appropriate remedial alternatives (in the feasibility study).

The site RI was conducted in four related programs:

- Soil and debris areas
- Wastewater discharge areas
- Surface water and sediment areas
- Sitewide groundwater

1.1 Purpose of This Document

This document summarizes the results of site investigations conducted from 1994 to 1999 for all environmental media other than groundwater. Key findings are presented, and references are provided to previous and concurrent documents for more detailed information. All information and data summarized in this document have been previously published in greater detail in documents submitted to the U.S. Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality (DEQ) during the course of the RI/FS.

The investigation results for groundwater, including the hydrogeologic setting and a description of surface water/groundwater interactions, are presented in the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999).

1.2 Organization of the RI/FS Documentation

The *Draft Remedial Investigation/Feasibility Work Plan* (CH2M HILL, May 8, 1996a) describes the strategies and processes developed to guide and complete the activities required for the RI/FS at the RMC site. This work plan was supplemented by six addenda. Five addenda focused on one or more individual areas or environmental media to identify any additional data needs: (1) soil and debris areas, (2) wastewater discharge areas, (3) south wetlands, (4) surface water and sediment areas, and (5) groundwater. South wetlands is considered a soil and debris area but was addressed in a separate addendum [*Draft South Wetlands Addendum to the RI/FS Work Plan* (CH2M HILL, May 8, 1996b)]. The sixth addendum was a work plan for the baseline risk assessment. Figure 1-1 is a graphical presentation of these documents.

Data needs identified in the addenda were addressed by further investigation and the results were reported in data summaries submitted to EPA as technical memorandums.

1.3 Sitewide Physical Setting

1.3.1 Location and Topography

The RMC facility is a primary aluminum reduction plant where alumina is reduced to aluminum. The plant is located approximately 20 miles east of Portland, Oregon, and 1.25 miles north of the City of Troutdale, Oregon, at the confluence of the Columbia and Sandy Rivers. RMC owns the 80.25-acre plant area and approximately 715 acres of surrounding rural land (see Figure 1-2).

The RMC property is bordered by the Columbia River to the north, the Sandy River to the east, the Troutdale Airport to the south, and Salmon Creek to the west. Figure 1-3 displays key site features. A U.S. Army Corps of Engineers (COE) flood control dike runs approximately east-west through the northern portion of the RMC property, then turns south near the eastern property boundary. The Troutdale Substation, located within the plant boundary, is owned and operated by the Bonneville Power Administration (BPA).

The site topography is generally flat, with some minor relief toward the north and north-east. Plant process buildings are located in the central portion of the site (see Figure 1-3 for area and building locations). Site areas north and east of the dike are within the 100-year flood plain; some areas also lie within the 10-year flood plain. The eastern part of the plant site inside the dike consists of open fields and storage areas. There are some wooded areas close to the plant fence. The eastern part of the plant outside the dike is generally a flat, sandy area with some vegetation cover. This area slopes down to the Sandy River and is subject to seasonal flooding.

North of the flood control dike, the topography is mostly flat, slopes gently towards the river, and is transected by numerous small east-west-trending drainages. The area is wooded, with relatively heavy vegetation in most areas. There is a beach on the Columbia River along the northern part of the property that is used occasionally for recreation.

1.3.2 Area Climate

The area is characterized by a mild, temperate marine climate with moderately warm, dry summers and wet winters. The average annual precipitation is approximately 37 inches. Forty to 50 percent of the total annual precipitation falls in January and February. The average daily maximum temperature is 62°F, and the average daily minimum temperature is 44°F (Ecology and Environment, Inc., 1991). RMC staff indicate that the prevailing winds near the plant site are from the south and southwest in summer and from the east in winter.

1.3.3 Land Use

This section provides information on land use to support an evaluation of potential exposure pathways and receptors.

The RMC property south of the flood control dike is currently zoned Urban Future (UF-20) and Urban Heavy Manufacturing (HM). Both of these zoning designations allow commun-

ity service uses under the provisions of Multnomah County Code (MCC) 11.15.7005-30 as a conditional use. The property north of the flood control dike is zoned UF-20, with overlays for Significant Environmental Concern (SEC) and Flood Fringe (FF).

Recently, zoning changes have been proposed for the area surrounding and including the RMC site. The Troutdale City Council has recommended to the Multnomah County Planning Commission (MCPC) that unincorporated land north of the City of Troutdale (that is, RMC, Gresham Sand & Gravel, Sundial Marine Tug & Barge Works, Inc., along with Bonneville Power Administration, Pacific Power & Light, and Portland General Electric property) be zoned General Industrial, with the exception of RMC property north of the dike, which would be zoned Open Space.

Access to the RMC facility is limited by a chain link perimeter fence surrounding the plant. Access to RMC areas east and south of the plant is limited by barbed wire fencing. The areas to the north and east of the COE flood control dike are partially fenced, and access from RMC property is regulated; recreational users are allowed to use the outfall access road to fish on the Columbia River shoreline but are asked to sign in with RMC before entering the area. Vehicles other than RMC's are not allowed on the outfall road, and the road is fenced on both sides.

The surrounding area to the west and south of RMC-owned land is mainly used for agricultural and commercial purposes. The Port of Portland's Troutdale Airport is located approximately 0.25 mile south of the RMC property.

1.4 Plant and Project History

1.4.1 Plant History

The plant was constructed for the U.S. Government in 1941 for wartime operations. RMC first leased the plant from the government in 1946 and purchased it in 1949. For a description of plant operations, see the *Draft Current Situation Summary* (CH2M HILL, April 5, 1996).

In 1992 and 1993 EPA conducted a site inspection prioritization (SIP) project, including a review of background information and a site visit to conduct limited sampling. The results of this work are summarized in the *Final Site Inspection Prioritization Report* (PRC, October 19, 1993).

1.4.1.2 Historical Waste Generation

A number of wastes are generated at the RMC plant during the production of aluminum. Twenty-one separate waste streams have been identified. These waste streams are described in Section 4.1.2 of the *Draft Groundwater Remedial Investigation Report* (titled Summary of Past Waste Disposal Practices Potentially Affecting Groundwater). Table 4-1 of that document provides a comprehensive list of waste streams generated at the RMC plant.

1.4.2 Project History

The site was placed on the National Priorities List in 1994, making it a "superfund" site. In June 1994 RMC began investigation and sampling at the site. Based on past operations,

samples were analyzed for fluoride, cyanide, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and EPA priority pollutant metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc). Some samples were analyzed for solvents, pesticides, other metals, and petroleum hydrocarbons. From this general list of constituents, a shorter list was developed during preliminary risk assessments at each area in collaboration with EPA on the basis of actual detections and reasonably expected exposures.

1.5 Early Actions

Early in the project RMC and EPA agreed to perform early actions as much as possible to achieve risk reduction to acceptable levels before completion of the RI/FS process and signing of the record of decision (ROD). RMC has completed several such early actions, as summarized in Table 1-1. Section 2.1 describes in more detail the early actions completed in the soil and debris areas.

TABLE 1-1
Summary of Early Actions at Reynolds Metals Company

Area	Action Taken
East Potliner	Excavation and disposal of over 11,148 tons of spent potliner (K088) and contaminated soil from east potliner area.
Cryolite Ponds	Removal of approximately 13,900 tons of cryolite material and contaminated soils from unlined impoundments of cryolite, including three recovery ponds located south of the facility.
Bakehouse Sumps	Removal and abandonment of well points at the bakehouse. Removal of approximately 283 tons of contaminated soils from the sumps, and modification of the sumps to bring them into compliance with Oregon Water Resources Department regulations.
Electrostatic Precipitator (ESP) Containment Area	Removal of approximately 1,193 tons of material and material replacement adjacent to the ESP tower, construction of a new washdown water containment area and butt-can drainage facility, and modification of process piping to capture and reuse water from sumps 16, 17, and 18.
Casthouse	Polychlorinated biphenyl (PCB) dust removal, concrete removal and decontamination, siding removal and soil excavation.
PCB Spill Area	Characterization, excavation, and disposal of PCB-contaminated soil from spill area south of the casthouse.
South Ditch Forebay	Dredging for maintenance purposes.
Diesel Spill Area	Contaminated soil removal.
Sitewide Access Restrictions	Warning signs posted around Company Lake and north landfill and grazing halted at Fairview farms. Fencing installed along outfall road adjacent to Company Lake and north landfill.
Production Well Decommissioning	The following production wells were decommissioned: PW04, PW06, PW09, PW11, PW12, PW14, PW15, PW16, PW17.

1.6 Background Data Summary

Background data were collected to evaluate the nature and extent of potential releases in order to distinguish between background conditions and site-related sources. Background data were compiled for the following environmental media using existing data, data from other sources, and data collected during summer 1996:

- Soil (upland and wetland)
- Sediment (Columbia River, Sandy River, and Salmon Creek)
- Surface water (Columbia River, Sandy River, and Salmon Creek)
- Groundwater (shallow and deep)
- Fish tissue (Columbia River)

The results are presented in *Technical Memorandum DS No. 12: Background Data Summary—Troutdale* (CH2M HILL, December 3, 1996) and are summarized in the appendix to this document.

In addition, the baseline risk assessment considered background conditions to help identify chemicals of potential concern.

Figures

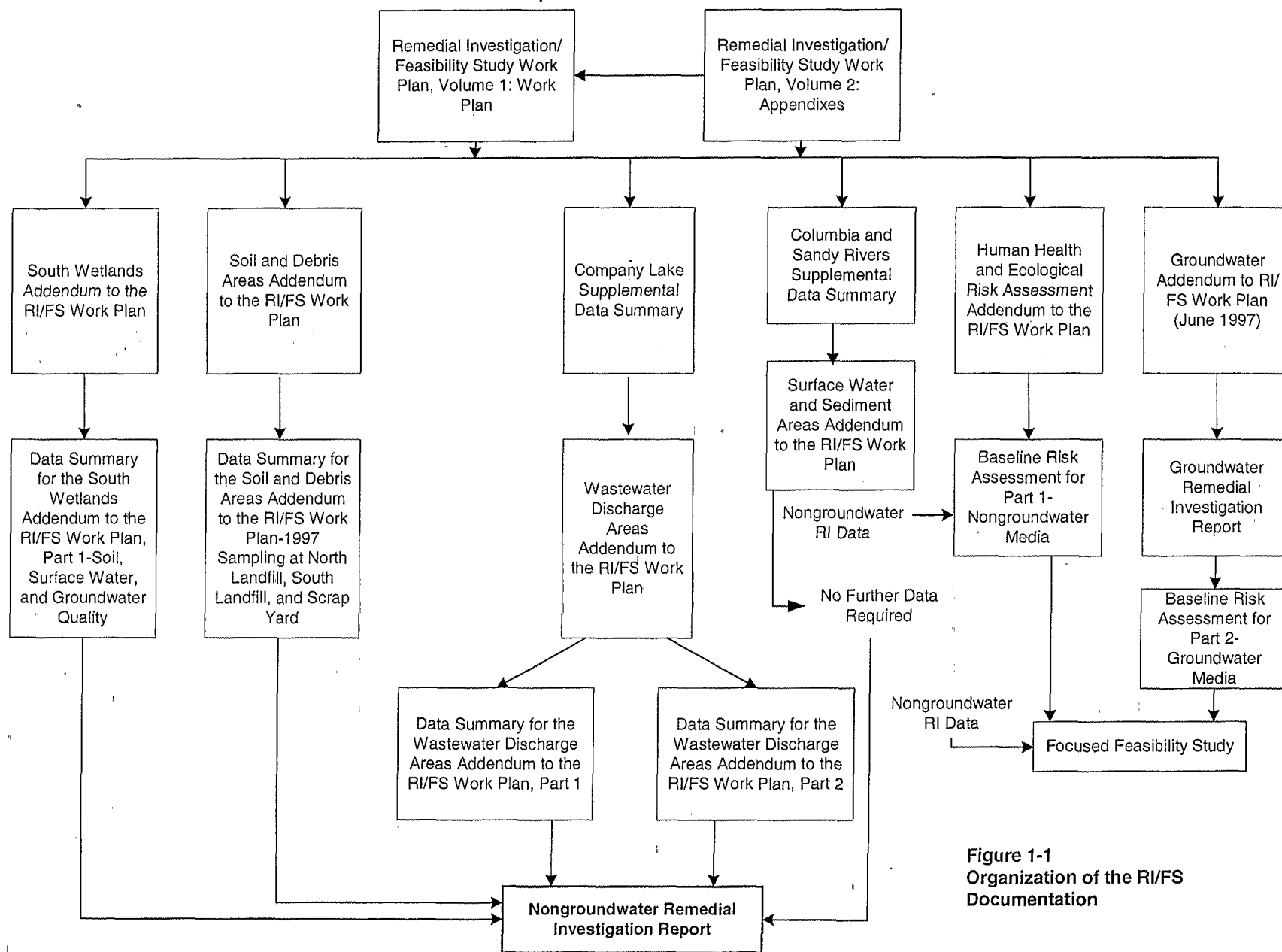
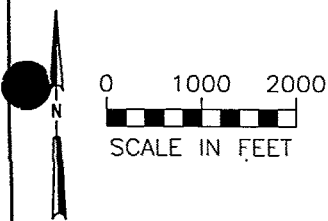
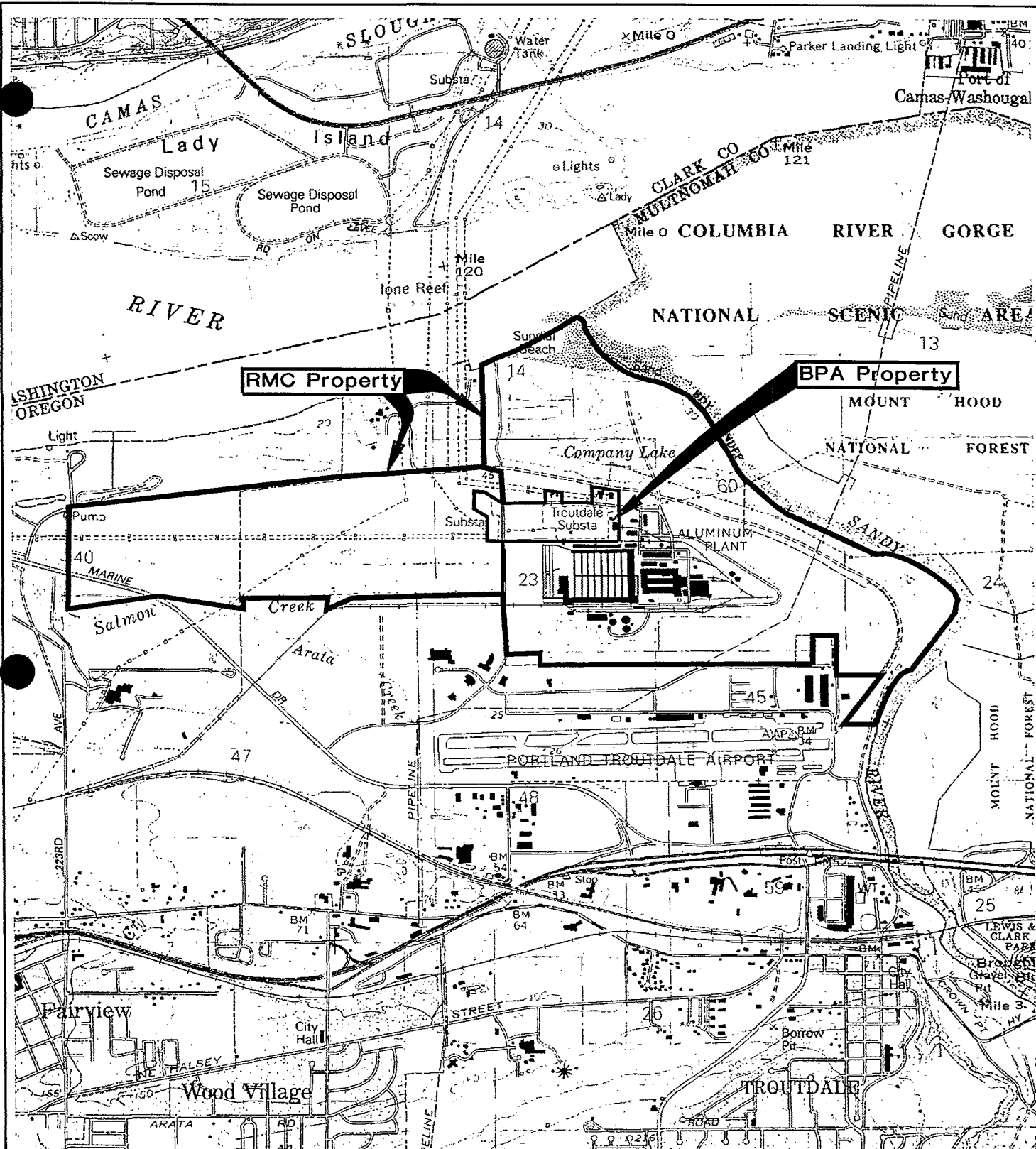


Figure 1-1
Organization of the RI/FS
Documentation



LEGEND
 ——— APPROXIMATE RMC
 PROPERTY BOUNDARY

**Figure 1-2
 VICINITY MAP**
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report



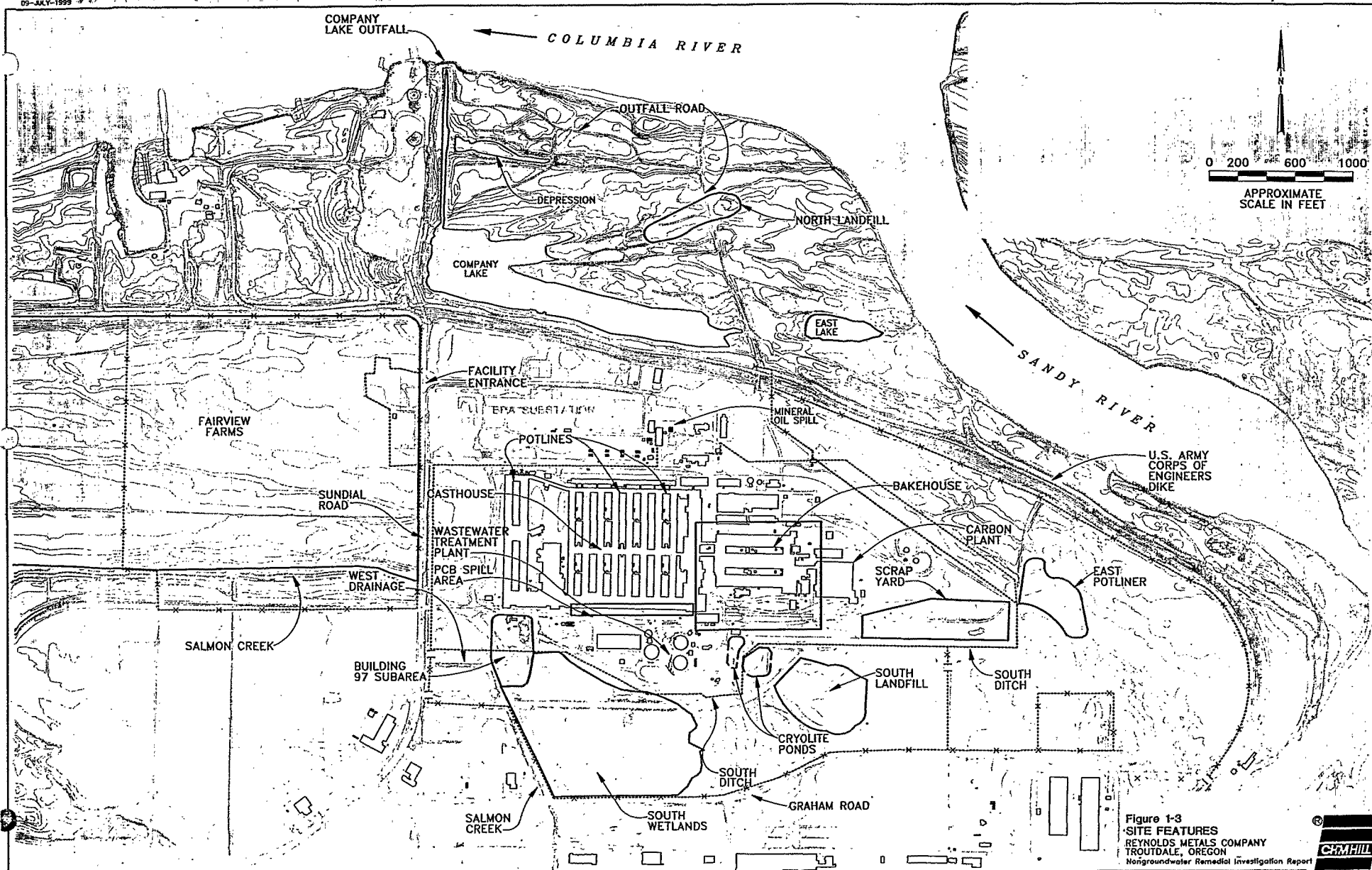


Figure 1-3
SITE FEATURES
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial Investigation Report



SECTION 2

Soil and Debris Areas

SECTION 2

Soil and Debris Areas

This section presents an overview of data gathering activities and findings for the soil and debris areas at the RMC Troutdale facility. The boundaries of each area were defined on the basis of physical characteristics and historical activities that indicated the extent of potential sources of chemical constituents.

Ten soil and debris areas have been identified at the RMC Troutdale facility:

- East potliner
- Cryolite ponds
- Bakehouse sumps
- Polychlorinated biphenyl (PCB) spill area
- Scrap yard
- North landfill
- South landfill
- Fairview Farms
- Mineral oil spill area
- South wetlands (addressed in Section 3 of this report)

Figure 2-1 is a sitewide map showing the locations of the soil and debris areas.

Early actions have been conducted at several of the soil and debris areas. Investigations of these areas were conducted between June 1994 and December 1995 and provided sufficient information to justify early actions designed to address immediate public health or environmental threats. Early actions were conducted at east potliner, cryolite ponds, bakehouse sumps, and the casthouse/PCB spill area.

A summary of these actions is presented in Section 2.1. Remedial investigations of the remaining five areas (scrap yard, north landfill, south landfill, Fairview Farms, and the mineral oil spill area) are summarized in Sections 2.2 through 2.6.

2.1 Early Actions in the Soil and Debris Areas

2.1.1 East Potliner Area

This section contains a description of the east potliner soil and debris area and a summary of early actions conducted in this area. More detailed information related to the east potliner area can be found in *Final Report: East Potliner Area Removal Action* (CH2M HILL, April 3, 1997).

2.1.1.1 Description of the East Potliner Area

The east potliner area lies east of scrap yard and inside the U.S. Army Corps of Engineers (COE) flood control dike (see Figure 2-1), just outside the RMC access control fence. The area encompasses about 3 acres, and is bisected by a Northwest Pipeline Corporation right-

of-way containing two buried 30-inch-diameter high-pressure gas pipelines. A railroad spur passes along the southern perimeter of the area.

Aerial photographs indicate that, from the early days of plant operation, east potliner was used as a temporary storage area for plant solid waste. Waste thought to have been stored in this area was primarily spent potliner, but it also included rodding room waste, carbon plant waste, cryolite, demolition waste, and used refractory brick. Waste material is not evident in aerial photographs taken after 1975 when, according to RMC personnel, approximately 6,000 tons of spent potliner were removed and transported to RMC's Longview, Washington, facility for recycling.

The east potliner area was identified as a potential source of constituents to groundwater by RMC in the summer of 1994. The area was initially investigated in July 1994. This investigation is documented in *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995). Supplemental investigations of soil and groundwater in the area occurred in February 1995 [*Technical Memorandum DS No. 3: East Potliner Area: Supplemental Data-Gathering Summary* (CH2M HILL, June 15, 1995)]. This work was followed by physical characterization of spent potliner location and depth in May 1995 [*Memorandum WP No. 7: Final East Potliner Area Work Plan for Removal Action* (CH2M HILL, October 11, 1995)].

2.1.1.2 Early Actions in the East Potliner Area

Beginning in August 1995, RMC began removal of old spent potliner and other waste material from the east potliner area. The removal activities included completion of an electromagnetometer (EM) survey over the entire area to help verify that all buried spent potliner was found and removed.

Excavation activities continued into the winter months, when work had to be halted intermittently because of heavy rains. As of January 8, 1996, when known deposits of potliner material had been removed and excavation was halted to conduct another EM survey, 11,148 tons of material had been removed from the east potliner area and landfilled.

A final EM survey was conducted in early January 1996. This survey indicated that some areas still contained a small amount of buried waste material or surface debris. Suspect areas were marked and excavated. Some surficial potliner was found, along with some metal sheets and concrete debris. One of the delineated areas containing a small amount of potliner (an area approximately 22 x 22 feet) was within the gas pipeline trench. This material was left in place for safety considerations. At the conclusion of excavation activities in the east potliner area in January 1996, confirmation samples were collected. The data are reported in *Final Report: East Potliner Area Removal Action*. RMC covered the area in September and October 1996 with a geotextile fabric and 1 to 2 feet of clean soil, regraded the area for improved drainage, and reseeded the area for erosion prevention.

2.1.2 Cryolite Ponds

This section contains a description of the cryolite ponds soil and debris area and a summary of early actions conducted in this area. More detailed information related to cryolite ponds can be found in *Final Report: Cryolite Pond Area Removal Action* (CH2M HILL, April 11, 1996).

2.1.2.1 Description of Cryolite Ponds

The cryolite ponds area is located south of the plant, adjacent to South Ditch, and northwest of south landfill (see Figure 2-1). The main pond, approximately 160 feet in diameter, was bounded on the north and west by South Ditch. Two smaller "satellite" ponds were located on the opposite side of the South Ditch, to the northwest of the large pond. The ponds were used for the storage and recovery of reclaimed cryolite. Cryolite is sodium aluminum fluoride (chemical formula Na_3AlF_6) and is the catalyst used in the electrolytic reduction of aluminum at the Troutdale plant. It is believed that the cryolite ponds were constructed by pushing the native soil into a berm and deepening the centers.

Aerial photographs and information from RMC personnel indicate that the cryolite ponds were probably constructed in 1965. The ponds were used to dispose of the carbon float from experimental carbon flotation cells used until about the 1970s, and to store underflow solids that occurred under a process upset in 1968.

The main pond was sampled in 1993 by PRC Environmental Management, Inc. (PRC) as part of the site inspection prioritization (SIP) investigation. Two samples were collected, one from the surface and one at a depth of 1 foot. Significant concentrations of sodium (5 and 11.5 percent), aluminum (20.7 and 32.2 percent), and total fluoride (13.4 and 19.8 percent) were detected in both samples. Results of the SIP investigation are presented in the *Final Site Inspection Prioritization Report* (PRC, October 19, 1993).

2.1.2.2 Early Actions at Cryolite Ponds

Cryolite Pond Removal Action, December 1994 to January 1995. In December 1994, RMC excavated and disposed of cryolite from the main cryolite pond and the two satellite ponds. The initial excavation objective for the cryolite ponds was removal of visible cryolite down to the native soil. Subsequently, target cleanup levels were established concurrent with the agencies as follows: 2,200 mg/kg total fluoride, 95 mg/kg cyanide, and 65 mg/kg arsenic.

Satellite Ponds. In January 1995, all visible cryolite was removed from the two satellite cryolite ponds, and two confirmation samples were collected from near the center of each pond. On the basis of the target cleanup levels, removal activities in both satellite ponds were considered complete.

Main Cryolite Pond. In January 1995, visible cryolite in the main pond was removed down to the point where groundwater was encountered. Approximately 12 feet of cryolite was excavated, and 1 to 3 feet was left in the pond bottom. Various dewatering and solidification options were considered. These options were determined to be prohibitively expensive when compared to the option of delaying further removal of cryolite until the drier summer months.

Two confirmation samples were collected from the main pond in shallow areas where excavation of cryolite had been completed. In addition, an excavation control sample was collected from approximately 2 inches below the cryolite that remained in the pond, in an effort to determine the depth below the bottom of the cryolite to which the excavation would have to proceed. The confirmation samples were analyzed for total fluoride, arsenic, and cyanide. The excavation control samples were analyzed only for total fluoride.

The analytical results showed that the removal action objectives had been met in the shallow areas where confirmation samples were collected. The analytical results for the excavation control sample indicated that target cleanup levels probably would be met in the remainder of the main pond once the cryolite excavation was completed.

A water sample was also collected from the main cryolite pond to evaluate the fluoride concentration of the water that was ponded and in contact with the cryolite in the excavation.

Additional Areas. During excavation of the south satellite pond, a thin, buried layer of cryolite was observed to extend south of the pond. Three test pits were excavated to approximately 4 feet bgs in this area to determine the extent of the cryolite layer. The soil overburden was identified as dredge spoils from South Ditch. Because South Ditch dredge spoils had not yet been characterized, the cryolite was left in place to be addressed for remediation in combination with the dredge spoils in subsequent actions at South Ditch.

Another small deposit of cryolite was discovered to the east of the north satellite pond. A test pit was excavated, and cryolite was visually identified from approximately 2 to 14 inches bgs. No samples from this area were collected for analysis. This area will also be considered in conjunction with actions conducted at South Ditch.

Cryolite Pond Removal Action, August 1995 to January 1996. Excavation of the remainder of the cryolite in the bottom of the main pond resumed in August 1995. Groundwater was still present in the lowest portion of the main pond. The excavated material was air-dried on a plastic liner placed adjacent to the cryolite pond and was then transported offsite and disposed. Most of the cryolite in the pond was removed by September 1995.

Analysis of confirmation samples collected after this excavation identified fluoride concentrations in excess of the target cleanup levels in 11 of the 42 grid sectors of the main cryolite pond (cleanup criteria for arsenic and cyanide were met in all grid sectors).

Additional excavation was completed in October 1995 in dry areas with fluoride concentrations exceeding the cleanup criterion. These areas were resampled after excavation and the fluoride concentrations in all samples were below the cleanup criterion.

In areas of the pond with standing water, it was determined that cleanup levels were not achieved because small amounts of cryolite were suspended in the water during excavation. This material then resettled on the bottom of the pond and formed a thin layer of high-fluoride material. After discussions with EPA, RMC elected to attempt final removal of the cryolite by dredging with a vacuum truck. Before the dredging was performed, a silt fence was set up in the pond bottom to isolate the grids that met the cleanup target concentrations from those that did not. The slurry that was removed from the pond bottom was pumped to the RMC industrial wastewater clarifier. The solids were separated out via the clarifier solids handling system for offsite disposal. After completion of this action in January 1996, two additional bottom samples were taken from below the water table. Although the cleanup level for fluoride was not achieved, RMC and EPA agreed that the overall goal for cryolite removal had been achieved and the action was deemed complete.

As a result of this action, approximately 13,900 tons of material were removed from the cryolite ponds area. Assuming that 90 percent of the excavated material was cryolite with a

fluoride concentration of 15 percent, then approximately 1,900 tons of fluoride were removed from the area ($13,900 \times 0.9 \times 0.15$).

2.1.3 Bakehouse Sumps Area

This section contains a description of the bakehouse sumps soil and debris area and a summary of early actions conducted in this area. More detailed information related to the bakehouse sumps area can be found in *Final Report: Bakehouse Sumps Area Removal Action* (CH2M HILL, April 27, 1998).

2.1.3.1 Description of Bakehouse Sumps Area

The location of the bakehouse is shown in Figure 2-1. The bakehouse sumps serve as a dewatering system to lower groundwater levels in and around the bakehouse below the base of the anode block bake-pits. The bake-pits are belowgrade concrete and refractory brick structures that are heated with natural gas to cure and harden the green carbon blocks. It is necessary to lower the groundwater in this area because moisture in the pits during baking can cause deterioration of the anode blocks.

Prior to the early actions, there were 21 dewatering sumps and 57 well points located in and around the bakehouse. The dewatering sumps are 4- to 4.5-foot-diameter perforated man-hole sections, 14 to 21 feet deep. The well points, which are 1- or 2-inch-diameter steel pipes approximately 31 feet long, are no longer connected to an active pumping system.

The dewatering sumps are constructed of both solid and perforated concrete pipe sections, each approximately 3 feet in length. They are fitted with float-switch activated pumps that discharge groundwater into onsite storm drains, which empty into South Ditch. The sumps appear to depress the water table approximately 10 to 12 feet below the expected static water table elevation in this area.

The buildings were originally designed with an area underdrain tile system that drained to manholes north of the complex and in the south courtyard. The well points were installed in 1957 and 1958 to augment or replace this system. The current sump system was installed between 1965 and 1970. Historically, stormwater runoff and waste have been able to enter some of the sumps because of their unprotected construction. In addition, condensate containing PAHs and other constituents from the wet ESP system was discharged to sumps 16 and/or 17.

2.1.3.2 Early Actions in Bakehouse Sumps Area

The bakehouse actions were initiated to address the following concerns:

- The well points and sumps were considered a potential pathway of soluble constituents to groundwater.
- The electrostatic precipitator system (ESP) process was improved to capture washdown water and clear liquor that would otherwise be discharged to storm drains.
- The process was improved to capture groundwater from three of the sumps to use for ESP makeup water in place of potable water and to prevent the discharge of condensate to the storm drainage system.

Actions at the bakehouse were completed in three phases:

Phase 1: Well Point Abandonment. Phase 1 removal action took place between June 10 and 19, 1996. The abandonment procedure consisted of either pulling the well point out of the ground or overdrilling and removing the well point. The resulting holes were subsequently grouted with bentonite slurry or backfilled with granular bentonite. State of Oregon Geotechnical Hole Report forms were filed with Oregon Water Resources Department (OWRD) for all well point abandonments.

Phase 2: Sump Cleaning, Soil Removal, and Reconstruction. All equipment associated with the sumps was removed and decontaminated by steam cleaning at the RMC site decontamination pad. Equipment that could not be adequately decontaminated was replaced by RMC; this equipment included piping and additional pumps. The interior concrete walls of the sumps were cleaned with a high-pressure steam washer until visible debris were removed. Soil was removed from the bottom of the sumps using a truck-mounted, air assisted vacuum system.

Each bakehouse sump was reconstructed to meet OWRD requirements for protection of groundwater. OWRD had indicated that the sumps did not fit clearly into any category of well or hole, so no specific construction standards could be applied without variance. Because application of "other hole" construction standards would have inhibited the intended operation of the sumps, OWRD used a set of special standards specific to the sumps.

Phase 3: ESP Area Removal Action. Phase 3 removal action was completed between June and November 1997.

The following activities were included as part of the Phase 3 removal action:

1. Six to 18 inches of existing gravel and soil were excavated, removed from the ground surface, and replaced with clean crushed rock in the areas between sumps 16 and 18. Three soil borings were completed, each to a maximum depth of 20 feet bgs.
2. A new 6-inch-thick concrete slab was placed around the ESP system in order to capture spills and runoff from the washdown of the precipitators.
3. The drainage lines for the overhead duct condensate drain and for three of the sumps were rerouted into the ESP makeup water system. Makeup water replenishes water lost as a result of evaporation and bleed-off requirements.
4. A concrete containment wall was built around the existing caustic tank.
5. A new butt-can drying shed was constructed for containment of drainage from tar that is collected from the ESP water settling tanks.
6. South of the ESP area, in an area previously used to store drying butt-cans, gravel and soil up to 18 inches deep were removed, along with a small soil berm stockpiled adjacent to the railroad tracks. This material was stockpiled together with the cuttings from the soil borings and the soil that was removed from the surface.

In addition, bakehouse sump 1 was abandoned in November 1997 by filling it with a sand-cement grout mixture to within approximately 4 feet of the ground surface. This work was

described in a 1996 memorandum titled *Abandonment of Bakehouse Sump No. 1 (Amendment to Memorandum WP No. 18)* (CH2M HILL, December 30, 1996).

2.1.4 PCB Spill Area and Casthouse

This section contains a description of the PCB spill area and casthouse and a summary of the early actions conducted in this area. The PCB remediation area (or PCB spill area) is immediately south of the casthouse. More detailed information related to this area can be found in *Final Report: Casthouse Remediation Area Removal Action* (CH2M HILL, April 9, 1998).

2.1.4.1 Description of PCB Spill Area and Casthouse

The casthouse foundry operation alloys molten metal and casts it into ingots (known as "pigs"). The casthouse contains two gas reverb furnaces that are used for holding and alloying the metal. These furnaces are situated between three "pigging machines," which are used for casting the molten metal. West of the furnaces and pigging machines, in the southwest corner of the facility, is a repair shop, which also contains electrical control equipment for the furnaces and pigging machines. This room previously contained electrical transformers that were used for the old electrical induction furnaces in the casthouse; thus, the room is called the "former transformer room." The electrical transformers were removed from the former transformer room in 1982 and 1990.

Built in 1942, the casthouse is one of the original reduction plant structures at RMC. In 1969, the loading and storage areas of the casthouse were extended west as potline 5 was built. The casthouse is a steel-framed building with a floor of either brick or concrete. The exterior of the original building was constructed using Robertson's Protected Metal (RPM) siding, manufactured by the H. H. Robertson Company in Pittsburgh, PA; the 1969 expansion used aluminum siding. Before July 1996, either original or replacement RPM siding still covered all of the original building, except for an area of approximately 40 lineal feet on the southwest corner of the original building, adjacent to the 1969 expansion area.

The PCB spill area is located just south of the casthouse, primarily between the casthouse and the first set of railroad tracks that run adjacent to the south side of the casthouse. The area, which is approximately 800 feet in length, generally extends from the battery room at the east end of the casthouse to an area just west of the former transformer room.

2.1.4.2 Early Actions in PCB Spill Area and Casthouse

On March 8, 1995, EPA issued an action memorandum directing that removal actions outside the casthouse be completed as a time-critical action. A draft work plan for the removal action for the casthouse interior was issued in February 1996 [*Memorandum WP No. 21: Draft Casthouse Interior Removal Action Work Plan* (CH2M HILL, February 20, 1996)]. A work plan for the exterior removal actions was prepared in May 1996 [*Memorandum WP No. 10: PCB Spill Area Removal Action Work Plan* (CH2M HILL, May 30, 1996)]. The work plans were reviewed by EPA, whose comments were incorporated. Work on the projects started in July 1996.

Data gathered in 1995 and 1996 indicated that soils south of the building were contaminated with PCBs. One source of contamination apparently resulted from deterioration and damage to the building's RPM siding, some of which may have contained PCBs at the time

of manufacture in the 1930s and 1940s. Other sources of contamination were not fully identified but may have been related to electrical equipment, railroad equipment, or hydraulic equipment. PCB contamination was also found on the floor of the former transformer room and along several of the passageways leading away from the room.

The data also indicated that there was PCB and metal contamination in the dust that had accumulated inside the building. The PCBs were thought to be from the deteriorated and damaged siding. The lead detected in the dust was likely from deteriorated paint, while the detections of other metals (arsenic, barium, cadmium, chromium) were probably a result of the processes that had occurred in the building and the materials that had been stored there.

Due to the layout of the area, the nature of the work, and to mitigate the chances of cross-contamination between the different operations, the removal actions were sequenced in three phases: the interior cleaning and dust removal was performed first, the siding was removed second, and the soil was excavated third. The second phase of the project (RPM siding removal) required a licensed asbestos abatement contractor to dismantle the siding.

Phase 1: Dust Removal, Concrete Removal, and Decontamination. A cleanup goal of $<10 \mu\text{g}/100 \text{ cm}^3$ PCB was set for the dust removal. The dust was removed using an industrial, trailer-mounted vacuum system with a double high-efficiency air (HEPA) filter at the exhaust end. The system supported as many as six vacuum hoses at one time. The dust and material were deposited in a drop box with a sealed lid to prevent fugitive dust emissions.

After dust removal, the steel surfaces were cleaned with cleaning solutions to remove the remnant dust, which may have contained PCBs. The final cleaning was performed with trisodium phosphate (TSP) and nylon brushes.

A portion of the former transformer room floor, approximately 8 feet by 20 feet in plan area, was demolished and removed. The remaining concrete floor in and adjacent to the former transformer room was cleaned with a solvent (TechXtract). The floor areas required several applications in order to achieve the cleanup goal ($10 \mu\text{g}/100 \text{ cm}^3$ PCB).

Phase 2: Siding Removal. Before any siding was removed, polyethylene sheeting was draped from the ceiling to the floor on the building interior and on the ground south of the building. The siding pieces were removed by hand and placed in lined drop boxes. After the sheets were removed, the trapped dust was collected with HEPA filtration vacuums. A surfactant was used as required to prevent dust generation from the sheets.

Phase 3: Soil Excavation. A cleanup goal of 25 mg/kg PCB with an additional goal of 10 mg/kg in surface soil was set for the soil excavation. The initial area and depths of excavation were estimated based on pre-action sampling. During construction, the depths and extent of the excavations were adjusted based on confirmation sample results. The excavation started at the south end of the building and extended south to the second set of railroad tracks.

2.2 Scrap Yard

This section contains a description of the scrap yard soil and debris area (referred to in this document as "scrap yard") and a summary of RI activities conducted in this area. More

detailed information related to investigation activities at scrap yard can be found in the documents below.

- *Final Site Inspection Prioritization Report* (PRC, 1993)
- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Technical Memorandum DS No. 6: Scrap Yard Supplemental Data-Gathering Summary* (CH2M HILL, November 27, 1995)
- *Draft Current Situation Summary* (CSS) (CH2M HILL, April 5, 1996)
- *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan* (SDA) (CH2M HILL, February 18, 1997)
- *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan – 1997 Sampling at North Landfill, South Landfill, and Scrap Yard* (CH2M HILL, December 15, 1997)
- *Draft Groundwater Remedial Investigation Report, Appendix B: Summary of 1998 Field Data Collection at South Landfill, Scrap Yard, and East Potliner* (CH2M HILL, June 1999)

2.2.1 Description of Scrap Yard

Scrap yard is located east of the bakehouse, just north of South Ditch (see Figure 2-1). It lies within the fenced area formally designated as the Troutdale facility plant and covers approximately 5¾ acres. Scrap yard is flat, sparsely vegetated, and has been deposited with debris, which includes brick fill and other manufacturing byproducts. The depth of the debris is typically less than 2 feet, and scrap metal and other materials are currently stored on the ground surface. Rail lines and gravel roads cross the area.

The area is mostly flat, with a slight depression in the southeast corner. Precipitation generally infiltrates to groundwater; little surface drainage has been observed. Groundwater elevation data indicate that groundwater levels may rise nearly to the ground surface during periods of high water, particularly in the eastern portions of scrap yard.

Aerial photographs indicate that portions of scrap yard were used for material storage prior to 1956. A 1971 aerial photograph indicated that potliner or other plant waste may have been stored temporarily in scrap yard. (No signs of potliner waste were evident during the site investigations.) In 1991, metal in scrap yard was removed and sent to local recyclers. In 1993, an area where mercury rectifiers had been stored was remediated to remove spilled mercury. The scrap yard continues to be used by RMC for scrap storage.

2.2.2 Summary of Investigations at Scrap Yard

Several field efforts have been conducted at scrap yard since 1994. These investigations have included collection of surface and subsurface soil samples. Table 2-1 presents a summary of the investigations.

2.2.3 Nature and Extent of Chemical Constituents at Scrap Yard

The *Draft Current Situation Summary* contains detailed site and data descriptions for scrap yard based on data collected in 1994 and 1995. The following summary is derived from Section 3.4 of that report. Additional PCB data were collected in 1997 and are reported in *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard*. That data is also summarized below.

2.2.3.1 Summary of 1994 and 1995 Data

Constituents investigated at scrap yard include fluoride, cyanide, polynuclear aromatic hydrocarbons (PAHs), PCBs, and metals.

Fluoride. Fluoride was detected in all but one of the soil samples collected from scrap yard. The maximum fluoride concentration detected in the surface soils was 100,000 mg/kg; the maximum fluoride concentrations in the composite subsurface samples were 1,400 mg/kg for three depths and 1,800 mg/kg for two depths.

Cyanide. Cyanide was found in 18 of the 24 soil samples analyzed from scrap yard. Maximum concentrations of cyanide detected in the discrete surface samples (19.5 mg/kg) are similar to those in the composited subsurface samples (21 mg/kg), suggesting that cyanide is distributed somewhat uniformly throughout the sample depth.

PAHs. PAHs were analyzed in discrete and composited samples. This sample distribution and the frequency of PAH detection in these samples are summarized in Table 2-2.

Concentrations of carcinogenic PAHs (cPAHs) found in discrete surface soil samples are presented in Table 2-3.

PCBs. Total PCBs were measured in 11 discrete surface soil samples and 13 composite samples; however, the PCB results from the 1994 and 1995 sampling events were superseded by the results from the 1997 PCB Analytical Method Investigation, as described in Section 2.2.3.2. No discrete samples from the subsurface were analyzed. Total PCBs were found in all surface samples, with a maximum concentration of 29.1 mg/kg, and a mean of the 11 samples of 7.1 mg/kg. Total PCBs were detected in 5 of the 13 composite samples analyzed. The highest concentration detected in the composite samples was 1.3 mg/kg. As with the PAHs, PCBs appear to be confined primarily to the surface soil.

Metals. Metals were analyzed in nine surface samples and three composite samples. Maximum concentrations detected for both sample sets are shown in Table 2-4, along with the analytical detection limits and detection frequencies.

A comparison of concentrations of metals between surface and subsurface samples indicates that their distribution in the soil profile is limited primarily to shallow soils. Maximum concentrations of beryllium and copper are similar in the two sample sets, while arsenic concentrations may be higher in the surface soils. Subsurface samples were not analyzed for all metals.

2.2.3.2 1997 PCB Analytical Method Investigation

Although the *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan*, or SDA, identified no data needs for scrap yard, questions later arose about the usability of the PCB data for surface soil samples collected during the supplemental data-gathering investigation in 1995. Since the surface exposure risk evaluation presented in the SDA included these data, resampling and analysis of surface soils for PCBs were determined to be needed for scrap yard. This section reports the data and results of the 1997 investigation.

Data Collection Procedures. Nine discrete surface soil samples were collected at scrap yard on October 23, 1997. The surface soil sample locations were surveyed to reproduce, as nearly as possible, the locations sampled in July 1995.

Analytical Methods. During the supplemental data-gathering investigation in 1995, discrete surface soil samples were collected from nine locations within scrap yard. Oregon Analytical Laboratory (OAL) analyzed these surface soil samples for PCBs, as well as for other organic and inorganic constituents.

A standard laboratory audit of OAL in September 1996 indicated that the OAL sample preparation/extraction methodology for PCB analyses differed from EPA standard methodology [EPA SW846 and Contract Laboratory Program (CLP)]. The OAL standard operating methodology for all PCB sample preparations was a laboratory-specific shakeout procedure developed for quick turnaround.

As a result of the laboratory audit findings, an interlaboratory comparative study was performed to evaluate the usability of OAL PCB data, including the 1995 PCB results for soil samples collected from scrap yard. The results of the comparative study are presented in *Technical Memorandum No. 4: Interlaboratory Data Comparison for RMC-Troutdale* (CH2M HILL, September 16, 1997). The interlaboratory comparison study results indicated that, for higher PCB concentrations in soil (greater than 10 mg/kg), the OAL results may be biased low. The results also indicated that the significance of the observed differences at concentrations greater than 10 mg/kg (including two of the nine samples from the scrap yard) needs to be evaluated on an area-specific basis.

QAL analyzed the discrete surface soil samples collected during the resampling effort. The samples were analyzed for PCBs by CLP method, as described in *Memorandum WO No. 1: Work Order for QAL Analysis of RMC Soil and Water Samples in 1997* (CH2M HILL, March 12, 1997). Because of matrix interference, all samples were analyzed on a diluted basis, resulting in higher detection limits.

Analytical Results. The analytical results for the surface soil samples from the scrap yard are provided in Table 2-5. The table shows the concentrations of individual PCB compounds (from the 1997 sampling), as well as the concentration of total PCBs from the 1995 supplemental data-gathering investigation.

PCB compounds that were detected in the surface soil samples were Aroclors 1254 and 1268. Aroclor 1254 was detected in one of the nine samples at a concentration of 1.1 JP mg/kg, and Aroclor 1268 was detected in three of the nine samples at a maximum concentration of 0.67 JP mg/kg. The maximum concentration of PCB compounds was found in sample SY-SB01R.

Comparison of 1995 and 1997 PCB Data. The purpose of collecting the surface soil samples at scrap yard and analyzing them for PCBs was to confirm the concentration of PCBs in scrap yard surface soil, and to confirm the results of the preliminary evaluation of the scrap yard that were presented in the SDA. Rather than resample and analyze the two sample locations in question using both methods, all nine locations were resampled and analyzed using the EPA CLP method. This approach was conservative but provided consistent data for risk evaluation. As shown in Table 2-5, the concentration of detected individual PCBs in all samples is less than the concentration of total PCBs from the 1995 investigation.

Because of interference from the sample matrix, all samples were analyzed on a diluted basis, and reporting limits were adjusted accordingly. Consequently, there are several samples (SY-SB03R, SY-SB04R, and SY-SB05R) in which the reporting limits for the individual PCB compounds are higher than the concentration of total PCBs from the 1995 investigation. It should be noted, however, that according to the results of the interlaboratory comparison study, only the 1995 samples with concentrations of PCBs greater than 10 mg/kg were in question, and these results may be biased low. The 1995 results of samples corresponding to SY-SB03R, SY-SB04R, and SY-SB05R were less than 10 mg/kg and, hence, not in question. Sample SY-SB02R contained 29.1 mg/kg in 1995, but the 1997 results had anomalously high detection limits. However, use of these nondetect values to estimate potential exposure concentrations of PCBs for scrap yard as a whole (using one-half the detection limit) does not result in a significantly different estimate for 1997 (approximately 15 mg/kg) versus 1995 (approximately 12 mg/kg).

In 1998, Geoprobe probes were installed in scrap yard to assess the amount of fluoride remaining in soil that could be a continuing source to groundwater. The results of this investigation are reported in Appendix B of the *Draft Groundwater Remedial Investigation Report* and will be used in support of the Focused Feasibility Study (CH2M HILL, In Progress).

2.2.4 Fate and Transport Issues at Scrap Yard

Rainfall infiltration and subsequent leaching of constituents from surface contamination are the most significant mechanisms for transport of fluoride, cyanide, and metals to subsurface soil and groundwater. Sample results support this conceptual model, showing a distribution of these constituents through the soil profile. Because of their capacity to adsorb to soil, PAHs and PCBs do not readily migrate. Results of surface and subsurface soil samples indicate that these constituents remain in surface soil with little accumulation in the subsurface. Contaminant migration to groundwater is addressed in the *Draft Groundwater Remedial Investigation Report*.

Contaminant migration via surface water runoff, volatilization, or wind erosion are not considered to be significant migration routes at scrap yard due to the physical site conditions and surface soil contaminant concentrations.

2.3 North Landfill

This section contains a description of the north landfill soil and debris area and a summary of RI investigation activities conducted in this area. More detailed information related to investigation activities at north landfill can be found in the documents below.

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan (SDA)* (CH2M HILL, February 18, 1997)
- *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard* (CH2M HILL, December 15, 1997)

2.3.1 Description of North Landfill

North landfill is located in a wooded area north of the U.S. Army Corps of Engineers dike, as shown in Figure 2-1. Most of the landfill lies within the 10-year floodplain of the Columbia River. The outfall road from the RMC parking lot to Sundial Beach on the Columbia River crosses over the top of the landfill. About 20 percent of the fill is east of the road, and 80 percent is west of the road.

The topography of north landfill is relatively flat, with some grading to drain stormwater runoff. The landfill has no major surface drainage features. Depressions at the eastern and western ends may, however, occasionally collect a small amount of surface runoff from the landfill.

The surface area of the landfill is about 100,000 square feet (2.3 acres). Areal boundaries of the waste material have been approximately defined. Waste depths vary across the site from approximately 5 feet bgs to greater than 14 feet bgs. The volume of landfill material is estimated at about 33,000 cubic yards.

Aerial photographs suggest that north landfill was active from about 1968 to about 1985. Field observations included identification of carbon waste, refractory brick, and miscellaneous debris. Anode blocks were visually identified, along with ash and oily silt-like material in selected test pits. An unidentified blue and white material was found in several locations, and asbestos was identified in a sample of a fabric scrap found near the surface.

In addition, approximately 500 tons of crushed steel slag material is currently stored at north landfill. The pile was placed on plastic. The slag is intended for use in future construction projects on the RMC property.

2.3.2 Summary of Investigations at North Landfill

Several field efforts have been conducted at north landfill since 1994. These investigations have included collection and analysis of surface and subsurface soil samples. Table 2-6 presents a summary of the investigations.

2.3.3 Nature and Extent of Chemical Constituents at North Landfill

The primary source of constituents in the north landfill is buried waste material, including carbon waste, refractory brick, solid waste, demolition waste, and miscellaneous debris. The constituents associated with the waste materials have been found at elevated concentrations in the landfill.

Analytical results from soils investigations in north landfill in 1994 are presented in detail in the CSS. A summary of the distribution of detected constituents is provided in this section, including fluoride, cyanide, metals, PAHs, and PCBs. Tables 2-7 and 2-8 summarize the soil sample data collected in 1994 for north landfill.

Because of the nature of the source materials, it is likely that constituent concentrations in soil vary randomly throughout the north landfill area. The data collected in 1997 for the *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan*, however, indicate that surface soil concentrations are higher in an area on the east side (see Section 2.3.3.1). Observations during early investigations indicated that the east side of the landfill may contain a higher percentage of carbon waste. In addition, ash has been discovered only on the east side of the landfill.

Surface samples were collected in 1997 for the SDA to provide adequate coverage to yield a reliable estimate of risks across the landfill surface. Samples were collected along five evenly spaced transects. Within each transect, five evenly spaced samples were collected from the top 6 inches of soil and composited to generate a single sample per transect. In the event that data from one of the composite samples indicated the presence of an elevated concentration of a chemical constituent, the archived discrete samples from that transect were frozen to preserve them for further analysis. The results of the investigation and data can be found in *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard*. Surface sample collection locations are shown in Figure 2-2.

Discussed below are analytical data results for the surface and subsurface soil samples collected at north landfill in 1997.

2.3.3.1 Surface Soil—1997 Composite Samples

Table 2-9 provides the analytical results for the composite surface soil samples collected from north landfill. A brief discussion of the results is presented below.

Fluoride. Fluoride was detected in all five surface soil samples from north landfill. Concentrations of total fluoride ranged from 400 J to 12,000 J mg/kg; concentrations of soluble fluoride ranged from 2.7 to 1,400 D mg/kg; and concentrations of fluoride by the gastrointestinal (GI) extraction method ranged from less than the detection limit of 75 mg/kg to 3,639 mg/kg. [See *Memorandum WO No. 1: Work Order for QAL Analysis of RMC Soil and Water Samples in 1997* (CH2M HILL, March 12, 1997) for an explanation of the GI extraction method.] The highest fluoride concentrations were found in samples NL-SB006 and NL-SB018. The lowest fluoride concentrations by all three methods were found in sample NL-SB024.

Cyanide. Cyanide was detected in four of the five surface soil samples from north landfill. The highest concentration of total cyanide (3.31 mg/kg) was found in sample NL-SB006.

Metals. Metals were detected in each of the five composite surface soil samples. Table 2-10 summarizes the concentrations of metals found in the composite surface soil samples from north landfill. With the exception of mercury, the concentrations of all metals were highest in sample NL-SB006.

PAHs. PAHs were detected in all five composite surface soil samples from north landfill. Table 2-11 summarizes the concentrations of PAHs found in the surface soil samples from north landfill.

The results of the collection of surface soil identified one area (see transect NL-SB006 on Figure 2-2) in north landfill with elevated concentrations of PAHs. This area contributed significantly to 95 percent of total preliminary risk estimates for the overall exposure unit. The frozen discrete samples from that transect were therefore analyzed to determine whether the entire transect had elevated concentrations or whether one sample was responsible for elevated concentrations in the composite sample. Analytical results indicated that two of the five discrete samples had elevated concentrations of PAHs (see Table 2-12). The highest concentrations were in samples NL-SB002 and NL-SB003. These concentrations were two to three times higher than the composite sample concentrations.

PCBs. PCBs were detected in two of the five composite surface soil samples from north landfill. The only PCB compound detected was Aroclor 1268, which was detected at concentrations of 1.2 and 2.9 mg/kg in samples NL-SB030 and NL-SB018, respectively. PCBs were not detected in the other three samples.

2.3.3.2 Subsurface Soil—Composite Samples

Table 2-13 provides the analytical results for the composite subsurface soil sample collected from the test pit in the south-central part of north landfill. A brief discussion of the results is presented below.

Fluoride. Fluoride was detected in the test pit composite sample at a concentration of 5,090 mg/kg by the GI extraction method. Soluble fluoride was also detected in the test pit sample at a concentration of 690 mg/kg. The sample was not analyzed for total fluoride.

Cyanide. Total cyanide was detected in the test pit sample at a concentration of 13.7 mg/kg.

Metals. Twelve metals were found in the test pit soil sample above detection limits. Concentrations of detected metals ranged from 0.1 mg/kg (lead) to 105,000 mg/kg (aluminum).

PAHs. Fourteen different PAH compounds were detected in the test pit sample. The concentrations of detected PAH compounds ranged from 0.1 mg/kg (acenaphthene) to 2.9 mg/kg (fluoranthene).

PCBs. One PCB compound (Aroclor 1260) was detected in the test pit composite sample at a concentration of 0.89 mg/kg.

2.3.4 Fate and Transport Issues at North Landfill

Leaching of constituents from primary source materials appears to be the most significant mechanism for transport of constituents to groundwater. Constituents appear to have migrated to shallow groundwater, possibly as a result of rainfall infiltration or direct contact with the water table. PAHs and PCBs, which have low solubilities and do not readily migrate, appear to be confined to soil and waste materials. An evaluation of constituent concentrations in groundwater near north landfill is presented in the *Draft Groundwater Remedial Investigation Report*.

Once in groundwater, constituents can migrate to the Columbia or Sandy Rivers via groundwater discharge. Constituents in the surface soil also have the potential to enter surface water via stormwater runoff. However, flat surface grades and the lack of a significant surface water drainage feature at north landfill decrease the significance of the surface water runoff pathway.

2.4 South Landfill

This section contains a description of the south landfill soil and debris area and a summary of RI activities in this area. More detailed information related to south landfill can be found in the documents referenced below.

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan* (CH2M HILL, February 18, 1997)
- *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard* (CH2M HILL, December 15, 1997)
- *Draft Groundwater Remedial Investigation Report, Appendix B: Summary of 1998 Field Data Collection at South Landfill, Scrap Yard, and East Potliner* (CH2M HILL, June 1999)

2.4.1 Description of South Landfill

South landfill is located south of scrap yard and bakehouse, immediately south of South Ditch (see Figure 2-1). The landfill is bordered on the north by the plant chain-link fence and South Ditch, on the northwest by the former cryolite ponds, on the west by south wetlands, on the south by a barbed-wire fence, and on the east by the Northwest Natural Gas Company booster pump station and open fields. With an area of approximately 5 acres, south landfill is distinguished from surrounding land by a lack of vegetation and a surface cover of debris. The volume of waste present in the landfill is estimated to be approximately 44,000 cubic yards, with a maximum thickness of 6 to 7 feet.

The land surface is nearly level, with a slight dip toward the south and west. Precipitation either drains to the south and west as surface runoff, or percolates into shallow groundwater. Surface runoff may enter South Ditch by trickling through the elevated railroad grade, may enter south wetlands via the old Salmon Creek channel, or may infiltrate to the shallow groundwater. Standing water has been noted in a low area immediately south of the landfill during the rainy season. It is not known whether the source of the water is precipitation runoff or high groundwater. See Appendix A of the *Draft Groundwater Remedial Investigation Report* for a discussion of groundwater and surface water in this area of the facility.

South landfill was used for general waste disposal from the early days of plant operation. During construction of the rail spur that borders the south side of the plant, the area was

reportedly used for staging refractory and construction materials. Active use of the area for general disposal apparently ceased in the late 1960s. However, the area continued to be used for temporary storage into the 1970s. Recently, drill cuttings produced during installation of monitoring wells on the RMC site were screened for constituent content and stockpiled on the landfill. In addition, approximately 250 tons of crushed steel slag material is temporarily stored near the landfill area. The slag is intended for use in future construction projects on the RMC property. Brick and debris from Fairview Farms, drilling mud from the abandonment of production wells 9 and 14, and sediment from the maintenance dredging of the South Ditch forebay in January 1998, are also stockpiled at south landfill.

2.4.2 Summary of Investigations

Several field efforts have been conducted at south landfill since 1994. These investigations have included collection and analysis of surface and subsurface soil samples, and of surface water samples from a seasonal swale located at the landfill. Table 2-14 presents a summary of the investigations.

2.4.3 Nature and Extent of Chemical Constituents at South Landfill

The primary source of chemical constituents at south landfill is buried waste materials. Based on the remnant waste materials observed, past use of these materials, and analytical results obtained, it is likely that the constituent concentrations vary randomly throughout the area.

The *Draft Current Situation Summary* and the *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan* contain detailed summaries of data collected in 1994. A summary of the distribution characteristics for chemical constituents investigated is provided below. Figure 2-3 shows the locations of the test pits from which composite soil samples were taken.

Fluoride. Fluoride was detected in all 16 composite test pit samples. Concentrations were measured at 1,000 mg/kg in four samples, and only two samples had less than 100 mg/kg of fluoride. No pattern of contamination is evident when concentrations are plotted with sample locations. The sample with the highest concentration was collected from test pit SP11.

Cyanide. Total cyanide was detected in all but one composited test pit sample, and concentrations in nine samples measured greater than 1.0 mg/kg. The maximum concentration observed was 44 mg/kg in test pit C1.5.

Metals. Fifteen composite samples were analyzed for metals. Maximum concentrations for selected metals detected are shown in Table 2-15 with sample locations, detection frequencies, and analytical detection limits. Maximum metal concentrations were all observed in samples collected from test pits C1.5, SP10, and SP11. These pits are located within 200 feet of each other in the west-central part of the south landfill area. Otherwise, metal concentrations appear to be randomly located across the area.

PAHs. PAHs were detected in all but two test pit composite samples. A maximum total PAH concentration of greater than 10,000 mg/kg was measured in SP1. PAHs were observed in six other test pits at total concentrations greater than 500 mg/kg. During the removal site assessment (RSA), it was noted that most PAH detections were associated with a black, carbon-like material that was observed in more than half of the test pits. The composite samples containing total PAH concentrations of greater than 500 mg/kg were all collected from test pits on the east side of south landfill.

Sixteen discrete subsurface samples from 12 test pits were analyzed for individual and total PAHs. Total PAHs were not detected in 13 of the samples. Concentrations measured at B2-4, C1.5-6, and SP9-2.5 were 1.1, 120, and 3,900 mg/kg total PAHs, respectively. Sample distribution and the frequency of PAH detection in these samples are summarized in Table 2-16. Although no data are available for discrete surface samples, the fact that samples composited from surface and subsurface soil had more detects than the discrete subsurface samples indicates that most of the PAH contamination is probably in the surface soil.

Concentrations of cPAHs found in the composite samples are presented in Table 2-17.

PCBs. Total PCBs were detected at concentrations of up to 1.1 mg/kg in four of the 16 test pits sampled (SP9, SP10, E2, and E5). Five discrete subsurface samples collected from three test pits were analyzed for both total PCBs and individual aroclors. PCBs were not detected in four of the five samples, but in C1.5-6, Aroclor 1260 was detected at just above the detection limit. The composite sample from SP10 was also analyzed for individual aroclors; aroclors 1248 and 1260 were detected at 0.77 and 1.77 mg/kg, respectively.

There was no apparent pattern to the distribution of PCBs at south landfill.

TPH. Total petroleum hydrocarbon (TPH) analysis was conducted for sample SP1-C on the basis of field observations of an oily material. Petroleum hydrocarbons in the heavy oil range were detected at a concentration of 2,700 mg/kg.

In 1997, additional data were collected to support completion of the baseline risk assessment. The results of this investigation are presented below.

2.4.3.1 Surface Soil

Surface samples were collected throughout south landfill to yield a reliable estimate of risks across the landfill surface. Samples were collected along 10 evenly spaced transects. Within each transect, five evenly spaced samples were collected from the top 6 inches of soil and composited to generate a single sample per transect. In the event that data from one of the composite samples indicated the presence of an elevated concentration of a constituent, the archived discrete samples from that transect were frozen to preserve them for further analysis. Figure 2-4 shows the 1997 surface soil sample locations. The results of the investigation and data can be found in *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard*.

Analytical results for the composite surface soil samples from south landfill are presented in Table 2-18 and summarized below. A preliminary comparison of the composite data with screening risk levels indicated that all ten of the transects exceeded the screening levels for some constituent. For this reason, discrete samples were not analyzed.

Fluoride. Fluoride was detected in all surface soil samples at south landfill. Concentrations of total fluoride ranged from 6,200 J mg/kg to 18,000 J mg/kg.

Cyanide. Cyanide was detected in all 10 surface soil samples at south landfill. Concentrations of total cyanide ranged from 1.47 to 7.85 mg/kg.

Metals. Table 2-19 summarizes the concentrations of metals found in the composite surface soil samples from south landfill. The table shows the maximum concentration, the location of the maximum concentration, and the frequency of detection for each of the metals.

PAHs. PAHs were detected in all 10 composite surface soil samples at south landfill; Table 2-20 summarizes the concentrations of PAHs found.

The PAH compounds detected were acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. With the exception of fluorene, each of these compounds was detected in all 10 surface soil samples.

Detected concentrations of PAHs ranged from 0.075 J mg/kg (acenaphthene in sample SL-SB0006) to 530 mg/kg (fluorene in sample SL-SB012). The highest concentrations of PAHs were found in SL-SB012, while the lowest concentrations of PAHs were found in SL-SB006.

PCBs. The only PCB compound detected in the surface soil samples at south landfill was Aroclor 1268, which was detected in nine of the ten composite surface soil samples. The concentration of Aroclor 1268 ranged from 0.54 P mg/kg to 24 P mg/kg. The only sample in which Aroclor 1268 was not detected was SL-SB060, from the easternmost transect. The highest concentration of Aroclor 1268 was found in SL-SB018.

2.4.3.2 Surface Water

Table 2-21 provides the analytical results for the surface water samples collected from the swale just south of south landfill. A brief discussion of the results is provided below.

Fluoride. Fluoride was detected in both water samples. The concentration of fluoride was 42.1 and 59.3 mg/L in samples SL-SWO1 and SL-SWO2, respectively.

Cyanide. Total cyanide was detected in both water samples. The concentration of total cyanide was 0.042 and 0.026 mg/L in samples SL-SWO1 and SL-SWO2, respectively.

Metals. Aluminum, beryllium, and copper were the only metals detected in the surface water samples, and they were detected in both filtered and unfiltered water samples.

PAHs. PAHs were not detected in either of the surface water samples.

PCBs. PCBs were not detected in either of the surface water samples.

These data were screened against conservative ecological screening levels. None of the constituents exceeded these levels. (See p. 3-19 of *Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard.*)

2.4.4 Fate and Transport Issues at South Landfill

The primary sources of investigated constituents at south landfill are buried waste materials. There is no indication that wastes were disposed of systematically, and it is likely that constituents vary randomly throughout the landfill. Surface soil has been affected by contact with waste materials. Subsurface soil and shallow groundwater have also been affected by contact with waste materials or by leaching of constituents from the waste materials.

Groundwater elevation data indicate that the groundwater table rises above the bottom of the waste materials in south landfill when water levels are high. The proportion of land-filled waste materials that may be in contact with groundwater during these times is estimated at up to 50 percent.

South Ditch and south wetlands are the nearest downgradient surface water bodies that could potentially be affected by surface runoff or shallow groundwater discharge from south landfill. Groundwater/surface water interactions in the South Plant area are described in Appendix A of the *Draft Groundwater Remedial Investigation Report*.

2.5 Fairview Farms

This section contains a description of the Fairview Farms soil and debris area and a summary of investigations conducted in that area. Detailed information related to Fairview Farms can be found in the documents below.

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Technical Memorandum DS No. 5: Fairview Farms Supplemental Data-Gathering Summary* (CH2M HILL, January 24, 1996)
- *Draft Current Situation Summary (CSS)* (CH2M HILL, April 5, 1996)
- *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan (SDA)* (CH2M HILL, February 18, 1997)

2.5.1 Description of Fairview Farms

Fairview Farms is a 222-acre fenced area located west of the RMC plant, across Sundial Road. The area is generally flat, with some seasonal drainage channels. Dredge spoils are present along the banks of Salmon Creek and the central drainage ditch. Figure 2-5 shows the key features of the Fairview Farms area, including:

- High-voltage power lines, owned by various utilities, crossing the property
- A central drainage channel flowing east to west, approximately 600 feet north of Salmon Creek
- A northern drainage channel flowing east to west, just south of the COE dike
- A cultivated area of approximately 25 acres in the northwest corner of the property, currently planted in several varieties of berries

Seasonal drainage appears to move from east to west within the drainage channels. Several isolated low-lying areas collect seasonal drainage during periods of heavy rainfall. The north and central drainages and Salmon Creek drain into a surface water pond along the western edge of the Fairview Farms property. Blue Lake (located approximately 1.5 miles west of Fairview Farms) also drains into this surface water pond. The pond provides equalization for the Sandy-Multnomah County Drainage District's pump station, which is located at the southern edge of the dike. Gates and float-activated switches control the pond level by activating pumps that convey collected water into the Columbia River.

RMC purchased the Fairview Farms property in 1962. The property was used for agricultural purposes (grazing and farms) prior to 1941, when the RMC plant was constructed, and this use continues to the present. In recent years, the northwestern portion has been used primarily for crop cultivation and the eastern portion for cattle grazing. Cattle grazing on the eastern portion of the area was suspended in 1994 pending remedial investigation. Grazing resumed in 1997 and continues to present. The northwest corner of the property is currently leased for berry farming. As part of site maintenance activities, four brick and debris piles were removed from Fairview Farms and moved to the south landfill area during the fall of 1996.

Salmon Creek is periodically dredged by the Sandy-Multnomah County Drainage District. Dredge spoils have been placed along both sides of the creek. The central drainage has also been dredged in the past.

Fairview Farms was investigated because it might have been affected by the operations at the RMC facility through various routes of constituent transport, including airborne deposition, transport by surface waters, deposition of debris from plant production, and possible transport of constituents in groundwater from the plant site.

2.5.2 Summary of Investigations at Fairview Farms

Several field efforts have been conducted at Fairview Farms since 1994. These investigations have included collection and analysis of surface and subsurface soils, vegetation, dredge spoils, brick and debris piles, and surface water. Table 2-22 presents a summary of the investigations.

2.5.3 Nature and Extent of Chemical Constituents at Fairview Farms

The CSS contains a detailed summary of data collected in 1994 and 1995. A summary of the distribution characteristics for investigated constituents is provided below.

Fairview Farms is located downwind of the RMC plant site. Surface deposition of plant air emissions containing fluoride, and possibly metals, may have occurred during past operation of the RMC facility. Other than the mounds of debris (brick and miscellaneous debris) and dredge spoils, no distribution of waste materials has been identified in the area.

Table 2-23 is a summary of detected constituents in soils at Fairview Farms. Constituents present in soil include primarily fluoride, PAHs, and metals. The distribution of constituents in surface soil appears to be random; sample concentrations did not show a trend along the transects. Vegetation samples collected along the transects contained fluoride and metals,

constituents that also occur naturally in the environment. The concentrations of these constituents suggest that vegetative uptake of soil constituents is minimal.

Concentrations of fluoride and metals, naturally occurring constituents that do not degrade in the environment and may be susceptible to leaching, did not show a distinct decreasing trend with sample depth.

Concentrations of individual PAHs were generally below detection limits; where they were detected, concentrations were at or below 1.1 mg/kg. The prevalence of PAH detections, primarily in the northern transect surface soil samples, suggests the possibility that these constituents are present as a combined result of road oiling, vehicular traffic, and dust settling on the adjacent property. On the basis of discrete sample results, vertical migration of PAHs, which do not readily migrate in soil, appears limited.

Constituents present in the dredge spoils and debris and brick piles include PAHs, metals, and fluoride. Constituent concentrations in these samples do not appear to be associated with sample depth except at one station, where PAHs were detected at a depth of 2 feet but not at the surface. As a whole, the surface and subsurface constituent concentrations in the dredge spoils and debris piles were in the range detected in transect surface soil samples. Furthermore, constituent concentrations in samples collected from beneath the piles in native soil do not appear to be significantly higher than concentrations detected in surface soil samples. Consequently, leaching of constituents from the mounds appears to be minimal.

2.5.4 Fate and Transport Issues at Fairview Farms

Rainfall infiltration and subsequent leaching from surface materials appears to be the most likely mechanism for transport of constituents such as fluoride and metals to subsurface soil and shallow groundwater. However, low concentrations detected in surface and near-surface soil suggest that this is a minor pathway.

Particle transport and surface runoff are also potential mechanisms for transport of constituents from surface materials into the onsite drainage ditches or Salmon Creek. PAHs, fluoride, and metals were detected in sediment samples collected from the onsite drainage ditches. However, flat surface grades and vegetative cover decrease the significance of these migration pathways.

2.6 Mineral Oil Spill Area

This section contains a description of the mineral oil spill soil and debris area and a summary of investigation activities conducted in this area. Detailed information related to the mineral oil spill area can be found in the documents referenced below:

- *Addendum No. 1 to Draft Current Situation Summary: Mineral Oil Spill Area* (CH2M HILL, November 15, 1996)
- *Draft Soil and Debris Areas Addendum to the RI/FS Work Plan (SDA)* (CH2M HILL, February 18, 1997)

2.6.1 Description of Mineral Oil Spill Area

The mineral oil spill area is a flat, sparsely vegetated area approximately 1/4 acre in size located on the north end of the main plant area, just west of the main entrance to the facility interior, and just east of Building 30 (see Figure 2-1). Within the mineral oil spill area are three horizontal, aboveground storage tanks surrounded by a low earthen berm. A small pump house, disconnected and no longer in service, is located outside the southwest corner of the berm.

Surface soil within the bermed area is mostly silty sand. The ground surface outside of the bermed area is primarily grass. Railroad tracks and a graveled surface are located south of the berm. Surface drainage over the entire area infiltrates to the groundwater. The water table has been observed at approximately 3 to 5 ft bgs.

Since the beginning of plant operations in the 1940s, oil used to service electrical equipment was stored in tanks within this area. In the past, mineral oil was pumped from the storage tanks through the pump station southwest of the tanks to the rectifier yard via an underground pipeline. Portions of the pipeline have been removed, and the system is no longer in use. Currently, oil is transferred from the storage tanks to a holding tank on a railroad car for delivery throughout the plant. The three tanks located in the bermed area have never been used to store "PCB oil," which contains PCBs at concentrations greater than 50 mg/L. The tanks stored oil containing PCBs at concentrations much less than 50 mg/L.

Two separate spills were investigated at the mineral oil spill area. One spill resulted from a break in the pipe loop near the pumphouse. This pipe loop has been abandoned. Soil contaminated with oil from the pipe break was removed and replaced with clean sand and gravel. Another spill occurred near the shower room east of the rectifier yard.

In the summer of 1995, maintenance workers were attempting to remove a surface oil stain beneath one of the tank spigots within the bermed area. During this process they discovered oil-stained soils to a depth of approximately 3 ft bgs, where water was encountered. Free oil was observed on the surface of the water, but it was uncertain whether the free oil was in the groundwater or merely resulted from excavated soil falling into the excavation.

2.6.2 Summary of Investigations at Mineral Oil Spill Area

A descriptive summary of the investigation conducted at the mineral oil spill area is provided in Table 2-24. No data were collected at the mineral oil spill area in 1997 for the SDA.

2.6.3 Nature and Extent of Chemicals in Mineral Oil Spill Area

The history of mineral oil release in this area is unknown. TPH was detected at a concentration of 3,810 mg/kg 25 feet southwest of the berm, at a depth of 4.5 feet. Inside the berm, TPH was detected at 4 feet bgs at the west end of the tanks; the concentrations ranged from 12,300 mg/kg to 27,000 mg/kg. Figure 2-6 shows the soil boring locations and Figure 2-7 shows TPH results at those locations.

No semivolatile organic compounds (SVOCs) or volatile organic compounds (VOCs) were detected in any of the samples collected in the mineral oil spill area. Benzo(b)fluoranthene was detected at 0.4 mg/kg a few feet west of the outside berm at 2 ft bgs. Total PCB concentrations ranged from less than 0.3 mg/kg to 2.1 mg/kg, below the EPA

recommended cleanup levels of 10 to 25 ppm for industrial settings (EPA, 1990). The highest concentration was detected 25 feet southwest of the berm at a depth of 4.5 feet. Surface soil values ranged from less than 0.3 mg/kg to 1.62 mg/kg.

2.6.4 Fate and Transport Issues in Mineral Oil Spill Area

If mineral oil is present in sufficient quantity, it could form a light non-aqueous-phase liquid (LNAPL) that may infiltrate to the top of the groundwater and migrate to the surface water. LNAPL may migrate to Company Lake, but the oil booms at the discharge point would prevent LNAPL from entering the Columbia River.

Existing data are not sufficient to describe the hydrogeologic gradients in this area. In general, shallow groundwater appears to be in hydraulic connection with the deep groundwater zone, but LNAPL would not migrate to the intermediate or deep zone because it is lighter than water and relatively insoluble.

Because mineral oil is not soluble in water, stormwater infiltration through constituents in the surface soil would not increase migration of constituents from the area.

Tables

Table 2-1
Summary of Investigations at Scrap Yard

Investigation	Description	Key Findings	Reference
EPA Site Inspection (1993)	Three surface soil samples (analyzed for VOCs, SVOCs, metals, cyanide, fluoride, pesticides, and PCBs).	Elevated concentrations of PAHs, metals, cyanide, and fluoride.	<i>Final Site Inspection Prioritization Report</i> (PRC, October 19, 1993)
Removal Site Assessment (1994)	Fifteen test pits (analyzed for cyanide, fluoride, metals, total PAHs, and total PCBs).	Detected concentrations of CN, F, Metals, PAHs, and PCBs. PAHs were more prevalent in surface soils. PCBs detected in seven of 15 test pits. Half of the test pits contained bakehouse bricks near the ground surface.	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
Supplemental Data Gathering (1995)	Nine surface soil samples (analyzed for cyanide, fluoride, metals, total PAHs, and total PCBs).	Detected concentrations of F, metals, PAHs, and PCBs. CN data was rejected for QA/QC reasons.	<i>Technical Memorandum DS No. 6: Scrap Yard Supplemental Data-Gathering Summary</i> (CH2M HILL, November 27, 1995)
PCB Analytical Method Investigation (1997)	Nine surface soil samples resampled from locations of supplemental data gathering conducted in 1995 (see above) and tested for PCBs. Effort was part of a method comparison between two laboratories.	PCB concentrations were generally less than in the 1995 investigation. Lab comparison indicated that in samples with higher PCB concentrations (>10 mg/kg), the previous results analyzed by OAL were biased low.	<i>Technical Memorandum No. 4: Interlaboratory Data Comparison for RMC – Troutdale</i> (CH2M HILL, September 16, 1997) <i>Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard</i> (CH2M HILL, December 15, 1997)
1998 Field Investigation	Additional data needed for assessment of remedial actions: Geoprobe soil and water samples taken from six locations (analyzed for total fluoride, soluble fluoride, and moisture content).	The two highest concentrations of total fluoride (12,000 and 13,000 mg/kg) were found in the surface. Concentrations generally decreased with depth.	<i>Draft Groundwater Remedial Investigation Report, Appendix B</i> (CH2M HILL, June 1999)

Table 2-2
PAHs: Sample Distribution and Frequency of Detection at Scrap Yard (1994 and 1995)
Number of detects/samples analyzed

	Discrete Surface Samples Detection Frequency	Subsurface Samples	
		Composite (0.1, 2.0, 4.0 ft bgs) Detection Frequency	Discrete (2.0 or 4.0 ft bgs) Detection Frequency
Speciated PAHs	9/9	2/2	0/0
Total PAHs	2/2	5/11	0/6
Notes: PAH = polynuclear aromatic hydrocarbon. bgs = below ground surface.			

Table 2-3
cPAH Concentrations in Scrap Yard Surface Soils (1994 and 1995)

Analyte	Maximum Concentration Detected (mg/kg)	Upper 95% UCL
Benzo(a)anthracene	68	43
Benzo(a)pyrene	88	52
Benzo(b)fluoranthene	200	99
Benzo(k)fluoranthene	48	28
Chrysene	170	80
Dibenzo(a,h)anthracene	19	12
Indeno(1,2,3-cd)pyrene	56	38
Notes: cPAH = carcinogenic polynuclear aromatic hydrocarbon. UCL = upper confidence limit.		

Table 2-4
Metal Concentrations in Scrap Yard Soils (mg/kg) (1994 and 1995)

Metal	Surface Samples			Subsurface Samples		
	Maximum Concentration Detected	Detection Limit	Detection Frequency	Maximum Concentration Detected	Detection Limit	Detection Frequency
Ag	ND	1	ND	ND	ND	ND
Al	87,600	-	9/9	NA	NA	NA
As	25.9	-	9/9	6.7	-	3/3
Ba	234	-	9/9	NA	NA	NA
Be	20.9	0.5	7/9	30	1	2/3
Ca	19,900	-	9/9	NA	NA	NA
Cd	8.16	0.5	7/9	29	1	2/3
Co	16.7	-	9/9	NA	NA	NA
Cr	145	-	9/9	82	-	3/3
Cu	8,060	-	9/9	7,600	-	3/3
Fe	114,000	-	9/9	NA	NA	NA
Hg	6.24	0.2	7/9	0.55	-	3/3
K	1,520	-	9/9	NA	NA	NA
Mg	4,790	-	9/9	NA	NA	NA
Mn	1,200	-	9/9	NA	NA	NA
Na	65,400	-	9/9	NA	NA	NA
Ni	318	-	9/9	70	-	3/3
Pb	341	-	9/9	82	-	3/3
Sb	20.2	2.5	4/9	3.2	2.5	1/3
Se	1.7	1	3/9	ND	ND	0/3
Th	1	1	2/9	ND	ND	0/3
V	101	-	9/9	NA	NA	NA
Zn	399	-	9/9	83	-	3/3

Notes:

ND = not detected.

NA = not analyzed.

Data based on samples collected in 1994 and 1995.

- = Detection limit not reported because analyte was detected in all samples.

Table 2-5
PCB Concentrations in Surface Soil, Scrap Yard

Sample No. ^a	1997 Sample Results									1995 Results
	Aroclor 1016 mg/kg	Aroclor 1221 mg/kg	Aroclor 1232 mg/kg	Aroclor 1242 mg/kg	Aroclor 1248 mg/kg	Aroclor 1254 mg/kg	Aroclor 1260 mg/kg	Aroclor 1262 mg/kg	Aroclor 1268 mg/kg	Total PCBs mg/kg
SY-SB01R	0.360 U	0.730 U	0.360 U	0.360 U	0.360 U	1.100 JP	0.360 U	0.360 U	0.670 JP	10.400
SY-SB02R	3.800 U	7.700 U	3.800 U	3.800 U	3.800 U	3.800 U	3.800 U	3.800 U	3.800 U	29.100
SY-SB03R	3.900 U	8.000 U	3.900 U	3.900 U	3.900 U	3.900 U	3.900 U	3.900 U	3.900 U	5.440
SY-SB04R	4.200 U	8.600 U	4.200 U	4.200 U	4.200 U	4.200 U	4.200 U	4.200 U	4.200 U	0.811
SY-SB05R	3.600 U	7.300 U	3.600 U	3.600 U	3.600 U	3.600 U	3.600 U	3.600 U	3.600 U	0.927
SY-SB06R	0.180 U	0.370 U	0.180 U	0.180 U	0.180 U	0.180 U	0.180 U	0.180 U	0.180 JP	9.160
SY-SB07R	0.190 U	0.390 U	0.190 U	0.190 U	0.190 U	0.190 U	0.190 U	0.190 U	0.420 JP	0.497
SY-SB08R	0.190 U	0.390 U	0.190 U	0.190 U	0.190 U	0.190 U	0.190 U	0.190 U	0.190 U	2.840
SY-SB09R	0.390 U	0.800 U	0.390 U	0.390 U	0.390 U	0.390 U	0.390 U	0.390 U	0.390 U	1.380

^a Soil sample numbers are the October 1997 sample designations. However, the 1997 sample locations were surveyed to represent, as nearly as possible, the July 1995 sample locations.

P = The difference in PCB concentrations between the two columns of the analytical instrument exceeded 25 percent. The lower value is reported, per EPA CLP reporting standards.

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

U = The compound was analyzed for but not detected.

Table 2-6
Summary of Investigations at North Landfill

Investigation	Description	Key Findings	Reference
EPA Site Inspection (1993)	Waste samples were collected by PRC and analyzed for volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), metals, cyanide, and fluoride.	The analytical results indicated the presence of PAHs, metals, cyanide, and fluoride.	<i>Final Site Inspection Prioritization Report</i> (PRC, October 19, 1993)
Removal Site Assessment (1994)	Composite samples were collected from 17 test pits. Discrete samples from other locations were also collected. Samples were analyzed for cyanide, soluble fluoride, total metals, PCBs, PAHs, TPH, and toxicity characteristic leaching procedure (TCLP) for eight metals. One sample was analyzed for VOCs and one for asbestos.	Soluble fluoride and cyanide were detected in all samples collected. All metals detected in samples were below the DEQ soil cleanup levels or background concentrations except for beryllium. PAHs were detected in both the east and west areas. PCBs were detected in surface and subsurface soils.	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendices</i> (CH2M HILL, 1995)
Soil and Debris Areas Investigation (1997)	Composite surface soils samples were collected along five evenly spaced transects. Samples were analyzed for fluoride, cyanide, PAHs, PCBs, and total metals. A test pit was excavated in the south central portion of the landfill to native soil and a composite sample was collected from three depths.	Elevated concentrations of PAHs were discovered along 1 transect on the east end of the north landfill. The discrete samples from the transect composite were analyzed for PAHs separately and the high concentrations were found in two samples in a localized area. Metal concentrations were highest along the same transect. The known lateral extent of the landfill was extended as a result of the excavation of the test pit.	<i>Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan</i> (CH2M HILL, 1997)

Table 2-7
Summary of Metals and Inorganics Detected in North Landfill Soil (1994)

Constituent	Maximum Concentration Detected	Detection Limit	Detection Frequency
Inorganic Compounds (mg/kg)			
Asbestos (Chrysotile) (%)	80	-	1/1
Cyanide, Total	1.6	-	8/8
Fluoride, Soluble	490	-	7/7
Metals (mg/kg)			
Antimony	3.1	2.5	3/7
Arsenic	8.3	-	7/7
Beryllium	2.7	1	3/7
Cadmium	1.5	1	5/7
Chromium	28	-	7/7
Copper	1600	-	7/7
Lead	76	10	6/7
Mercury	0.25	0.25	2/7
Nickel	55	-	7/7
Selenium	1	1	2/7
Silver	1	1	2/7
Thallium	1	1	2/7
Zinc	180	-	7/7
TCLP Metals (mg/L)			
Barium	0.62	-	3/3
Notes: Constituents that did not have any detections were not included. NA = not available. Data based on samples collected in 1994. All results are from composite soil samples. - = Detection limit not reported because analyte was detected in all samples.			

Table 2-8
Summary of PAHs, PCBs, TPH, and VOCs Detected in North Landfill Soil (1994)

Constituent	Maximum Concentration Detected	Detection Limit	Detection Frequency
PAHs (mg/kg)			
Benzo(a)anthracene	190	5	1/2
Benzo(a)pyrene	280	5	1/2
Benzo(b)fluoranthene	350	5	1/2
Benzo(g,h,i)perylene	190	5	1/2
Benzo(k)fluoranthene	100	5	1/2
Chrysene	280	5	1/2
Fluoranthene	320	5	1/2
Indeno(1,2,3-cd)pyrene	190	5	1/2
Phenanthrene	140	5	1/2
Pyrene	310	5	1/2
Total PAHs	1400	0.2	5/7
PCBs (mg/kg)			
Aroclor 1248	15	0.05 - 5	1/12
Aroclor 1254	1.2	0.05 - 5	4/12
Aroclor 1260	31	2.5	11/12
Total PCBs	28	0.2	10/13
TPH (mg/kg)			
TPH - 418.1	120	NA	1/1
VOCs (mg/kg)			
VOCs	NA	NA	0/1
Notes: Constituents that did not have any detections were not included. NA = not available. Data based on samples collected in 1994.			

Table 2-9
Analytical Results, Composite Surface Soil Samples, North Landfill (1997)

Report Class	Analyte	Units	NL-SB006 6/18/97	NL-SB012 6/18/97	NL-SB018 6/18/97	NL-SB024 6/18/97	NL-SB030 6/18/97
CONV	Fluoride By 300.0	mg/kg	1400 D	41	1000 D	2.7	43
CONV	Fluoride By 340.1/340.2	mg/kg	9100 [J]	1000 [J]	12000 [J]	400 [J]	1800 [J]
CONV	Fluoride, GI Extraction	mg/kg	3630	222	2470	75 U	261
CONV	Cyanide, Total	mg/kg	3.31	0.55 U	2.44	0.77	1.6
M-TOTAL	Aluminum	mg/kg	25600	10800	22700	9260	18400
M-TOTAL	Antimony	mg/kg	3.5	2.8 U	3.2 U	3.4 U	3.3 U
M-TOTAL	Arsenic	mg/kg	13	2.8	8.1	3.8	6.7
M-TOTAL	Barium	mg/kg	108 [J]	46.4 [J]	79.1 [J]	84.8 [J]	83.4 [J]
M-TOTAL	Beryllium	mg/kg	4.3 [J]	0.55 U[J]	1.7 [J]	.68 U[J]	1.4 [J]
M-TOTAL	Cadmium	mg/kg	2.5	0.72	1.6	0.95	2.1
M-TOTAL	Chromium	mg/kg	45.9	25.7	20.5	11	33.3
M-TOTAL	Copper	mg/kg	8440 [J]	127 [J]	427 [J]	43.8 [J]	1180 [J]
M-TOTAL	Lead	mg/kg	68.3 [J]	11.9 [J]	45.1 [J]	17.7 [J]	44.4 [J]
M-TOTAL	Mercury	mg/kg	0.08 U	0.3	0.09	0.08 U	0.3
M-TOTAL	Nickel	mg/kg	111	27.2	86.4	17.3	44.2
M-TOTAL	Selenium	mg/kg	2.6	1.1 U	1.3 U	1.4 U	1.3 U
M-TOTAL	Silver	mg/kg	1.4 U	1.1 U	1.3 U	1.4 U	1.3 U
M-TOTAL	Thallium	mg/kg	1.4 U	1.1 U	1.3 U	1.4 U	1.3 U
M-TOTAL	Vanadium	mg/kg	112	50.1	61.1	45.9	65.6
M-TOTAL	Zinc	mg/kg	146	40.7	81.3	82.2	102
BNA	2-Methylnaphthalene	mg/kg	45 U	1.5 U	1.3 U	0.45 U	0.87 U
BNA	Acenaphthene	mg/kg	16 J	0.3 J	0.21 J	0.055 J	0.87 U
BNA	Acenaphthylene	mg/kg	45 U	1.5 U	1.3 U	0.45 U	0.87 U
BNA	Anthracene	mg/kg	26 J	0.34 J	0.39 J	0.089 J	0.16 J
BNA	Benzo(a)Anthracene	mg/kg	170	3.3	3.1	0.76	2.4
BNA	Benzo(a)Pyrene	mg/kg	230	5.2	3.3	0.85	2.2
BNA	Benzo(b)Fluoranthene	mg/kg	220	6.1	7.7	1.9	4.8
BNA	Benzo(G,H,I)Perylene	mg/kg	99	2	0.83 J	0.064 J	0.61 J
BNA	Benzo(k)Fluoranthene	mg/kg	160	5.1	4.1	1.3	4.1
BNA	Chrysene	mg/kg	180	4	4.3	1.1	3.8
BNA	Dibenzo(a,h)Anthracene	mg/kg	46	1.3 J	.92 J	0.17 J	0.41 J
BNA	Fluoranthene	mg/kg	280	4.8	5	1	2.6
BNA	Fluorene	mg/kg	5.7 J	1.5 U	1.3 U	0.45 U	0.87 U
BNA	Indeno(1,2,3-Cd)Pyrene	mg/kg	130	3.3	2.2	0.32 J	1.1
BNA	Naphthalene	mg/kg	45 U	1.5 U	1.3 U	0.45 U	0.87 U
BNA	Phenanthrene	mg/kg	140	2.1	2	0.43 J	0.69 J
BNA	Pyrene	mg/kg	230	3.7	3.7	0.85	2.4
PEST/PCB	Aroclor 1016	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1221	mg/kg	9.2 U	7.4 U	1.7 U	1.8 U	1.8 U
PEST/PCB	Aroclor 1232	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1242	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1248	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1254	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1260	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1262	mg/kg	4.5 U	3.7 U	0.86 U	0.9 U	0.87 U
PEST/PCB	Aroclor 1268	mg/kg	4.5 U	3.7 U	2.9	0.9 U	1.2

Notes:

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

U = The compound was analyzed for but not detected.

D = Results reported at more than one dilution factor.

Results based on samples collected in 1997.

GI extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be bioavailable.

Table 2-10
Metals Concentrations in Surface Soil, North Landfill (1997)

Metal	Maximum Concentration Detected (mg/kg)	Location of Maximum Detection	Detection Frequency
Aluminum	25600	SB006	5/5
Antimony	3.5	SB006	1/5
Arsenic	13	SB006	5/5
Barium	108 J	SB006	5/5
Beryllium	4.3 J	SB006	3/5
Cadmium	2.5	SB006	5/5
Chromium	45.9	SB006	5/5
Copper	8440 J	SB006	5/5
Lead	68.3 J	SB006	5/5
Mercury	0.3	SB030	3/5
Nickel	111	SB006	5/5
Selenium	2.6	SB006	1/5
Vanadium	112	SB006	5/5
Zinc	146	SB006	5/5

Notes:

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

Results based on samples collected in 1997.

Table 2-11
PAH Concentrations in Surface Soil, North Landfill (1997)

Compound	Maximum Concentration (mg/kg) ^a	Minimum Concentration (mg/kg) ^b	Frequency of Detection
2-methylnaphthalene	ND	ND	0/5
Acenaphthene	16 J	0.055 J	4/5
Acenaphthylene	ND	ND	0/5
Anthracene	26 J	0.089 J	5/5
Benzo(a)anthracene ^c	170	0.76	5/5
Benzo(a)pyrene ^c	230	0.85	5/5
Benzo(b)fluoranthene ^c	220	1.9	5/5
Benzo(g,h,i)perylene	99	0.064 J	5/5
Benzo(k)fluoranthene ^c	160	1.3	5/5
Chrysene ^c	180	1.1	5/5
Dibenzo(a,h)anthracene ^c	46	0.17 J	5/5
Fluoranthene	280	1	5/5
Fluorene	5.7 J	ND	1/5
Indeno(1,2,3-cd)pyrene ^c	130	0.32 J	5/5
Naphthalene	ND	ND	0/5
Phenanthrene	140	0.43 J	5/5
Pyrene	230	0.85	5/5

Notes:^a All maximum detected concentrations were found in sample NL-SB006.^b All minimum detected concentrations were found in sample NL-SB024.^c Indicates carcinogenic PAH.

ND = not detected.

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

Results based on samples collected in 1997.

Table 2-12
PAH Concentrations in Discrete Samples from One Transect at North Landfill (1997)

PAH Compound (mg/kg)	NL-SB006 (composite sample)	NL-SB001	NL-SB002	NL-SB003	NL-SB004	NL-SB005
Naphthalene	45 U	0.88 U	99 U	85 U	2.9 J	0.44 U
2-Methylnaphthalene	45 U	0.88 U	99 U	85 U	21 U	0.44 U
Acenaphthylene	45 U	0.88 U	99 U	85 U	21 U	0.44 U
Acenaphthene	16 J	0.22 J	48 J	47 J	7 J	0.068 J
Fluorene	5.7 J	0.092 J	16 J	20 J	3.4 J	0.44 U
Phenanthrene	140	1.6	300	310	73	0.44
Anthracene	26 J	0.32 J	70 J	76 J	18 J	0.075 J
Fluoranthene	280	3.7	570	590	110	1
Pyrene	230	3.4	510	540	110	1
Benzo(a)anthracene	170	2.5	400	430	85	0.75
Chrysene	180	2.8	430	450	96	0.78
Benzo(b)fluoranthene	220	2.7	430	440	94	0.84
Benzo(k)fluoranthene	160	3.1	400	350	91	0.98
Benzo(a)pyrene	230	2.9	360	470	86	0.88
Indeno(1,2,3-cd)pyrene	130	1.8	240	240	59	0.55
Dibenz(a,h)anthracene	46	0.73 J	100	95	25	0.22 J
Benzo(g,h,i)perylene	99	2.1	230	230	56	0.56
Notes: U = The compound was analyzed for but not detected. J = The reported value is estimated, since it is below the method reporting limit for the analysis. Results based on samples collected in 1997.						

Table 2-13
Analytical Results, Composite Subsurface Soil Sample, North Landfill (1997)

Report Class	Analyte	Units	NL-TP001 8/29/97
CONV	Fluoride, by 300.D	mg/kg	500
CONV	Fluoride, GI Extraction	mg/kg	5090
CONV	Cyanide, Total	mg/kg	13.7
M-TOTAL	Aluminum	mg/kg	105000
M-TOTAL	Antimony	mg/kg	3 U
M-TOTAL	Arsenic	mg/kg	21.2
M-TOTAL	Barium	mg/kg	80.8
M-TOTAL	Beryllium	mg/kg	9.2
M-TOTAL	Cadmium	mg/kg	1.3
M-TOTAL	Chromium	mg/kg	51.9
M-TOTAL	Copper	mg/kg	203 E
M-TOTAL	Lead	mg/kg	123
M-TOTAL	Mercury	mg/kg	0.1
M-TOTAL	Nickel	mg/kg	364 E
M-TOTAL	Selenium	mg/kg	12.2 U
M-TOTAL	Silver	mg/kg	1.2 U
M-TOTAL	Thallium	mg/kg	1.2 U
M-TOTAL	Vanadium	mg/kg	247
M-TOTAL	Zinc	mg/kg	202
BNA	2-Methylnaphthalene	mg/kg	0.8 U
BNA	Acenaphthene	mg/kg	0.1 J
BNA	Acenaphthylene	mg/kg	0.8 U
BNA	Anthracene	mg/kg	0.36 J
BNA	Benzo(a)Anthracene	mg/kg	1.1
BNA	Benzo(a)Pyrene	mg/kg	0.86
BNA	Benzo(b)Fluoranthene	mg/kg	1.2 [J]
BNA	Benzo(g,h,i)Perylene	mg/kg	0.17 J
BNA	Benzo(k)Fluoranthene	mg/kg	0.88
BNA	Chrysene	mg/kg	1
BNA	Dibenzo(a,h)Anthracene	mg/kg	0.22 J
BNA	Fluoranthene	mg/kg	2.9
BNA	Fluorene	mg/kg	0.12 J
BNA	Indeno(1,2,3-Cd)Pyrene	mg/kg	0.5 J
BNA	Naphthalene	mg/kg	0.8 U
BNA	Phenanthrene	mg/kg	1.8
BNA	Pyrene	mg/kg	1.9
PEST/PCB	Aroclor 1016	mg/kg	0.8 U

Table 2-13
Analytical Results, Composite Subsurface Soil Sample, North Landfill (1997)

Report Class	Analyte	Units	NL-TP001 8/29/97
PEST/PCB	Aroclor 1221	mg/kg	1.6 U
PEST/PCB	Aroclor 1232	mg/kg	0.8 U
PEST/PCB	Aroclor 1242	mg/kg	0.8 U
PEST/PCB	Aroclor 1248	mg/kg	0.8 U
PEST/PCB	Aroclor 1254	mg/kg	0.8 U
PEST/PCB	Aroclor 1260	mg/kg	0.89
PEST/PCB	Aroclor 1262	mg/kg	0.8 U
PEST/PCB	Aroclor 1268	mg/kg	0.8 U

Notes:

U = The compound was analyzed for but not detected above the method detection limit.

E = The reported value is estimated, since it exceeds the linear calibration range for the compound.

J = The concentration detected is estimated, since it is below the method detection limit.

Results based on samples collected in 1997.

GI extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be bioavailable.

Table 2-14
Summary of Investigations at South Landfill

Investigation	Description	Key Findings	Reference
EPA Site Inspection (1993)	Five samples collected from 1-foot depth and analyzed for cyanide, fluoride, PAHs, and metals.	Found elevated concentrations of cyanide, fluoride, PAHs, and metals.	<i>Final Site Inspection Prioritization Report</i> (PRC, October 19, 1993)
Removal Site Assessment (1994)	Excavated 11 test pits to native material and collected selected discrete samples and composite samples from 3 depths to characterize the landfill waste material. Samples were analyzed for cyanide, soluble fluoride, PAHs, PCBs, and metals. Select discrete samples were also analyzed for TPH.	Highest concentrations of fluoride, cyanide, and two metals were found in the west-central part of the landfill area. Highest concentrations of PCBs, and PAHs were found in the eastern half of south landfill. PAHs detected in all but 2 test pits. Fluoride and metals were detected throughout. PCBs detected in 4 test pits.	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
Soil and Debris Areas Investigation (1997)	Additional data needed for baseline risk assessment: Collected 10 composite surface soil samples along 10 transects. Analyzed for fluoride, cyanide, PAHs, PCBs, and metals. Collected two surface water samples from swale. Analyzed for fluoride, cyanide, PAHs, PCBs, and metals.	Comparison of chemical data from the 10 composite surface soil samples indicate that all 10 transects exceeded the preliminary risk levels for one or more constituents. Fluoride, cyanide, and dissolved and total aluminum, beryllium, and copper were detected in both surface water samples.	<i>Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan—1997 Sampling at North Landfill, South Landfill, and Scrap Yard</i> (CH2M HILL, December 15, 1997)
1998 Field Effort	Additional data needed for assessment of remedial actions: Six Geoprobe probes were taken and soil sampled at 5-foot intervals to total depth of approximately 45 feet. 59 samples were analyzed for total fluoride, and approximately half were also analyzed for soluble fluoride.	The highest concentrations of total fluoride were found in the top 5-feet of soil in waste material in 5 of the 6 Geoprobe locations. Higher soluble fluoride concentrations were generally found at depths below 5 feet, but were often undetected at depths below 25 feet. Fluoride concentrations generally decreased with depth.	<i>Draft Groundwater Remedial Investigation Report, Appendix B: Summary of 1998 Field Data Collection at South Landfill, Scrap Yard, and East Potliner</i> (CH2M HILL, June 1999)

Table 2-15
Metals Concentrations in Composite Soil Samples from South Landfill (1994)

Metal	Maximum Concentration Detected (mg/kg)	Location of Maximum Detection	Detection Frequency	Detection Limit (mg/kg)
Arsenic (As)	18	C1.5	12/17	1.0
Beryllium (Be)	9.1	C1.5	7/17	1.0
Cadmium (Cd)	4.5	SP11	8/17	1.0
Chromium (Cr)	220	C1.5	17/17	-
Copper (Cu)	36,000	C1.5	17/17	-
Mercury (Hg)	0.82	SP11	1/17	0.2
Nickel (Ni)	290	C1.5	17/17	-
Lead (Pb)	520	SP10	12/17	10
Antimony (Sb)	31	C1.5	8/17	2.5
Zinc (Zn)	850	SP11	17/17	-

Note:

Results based on samples collected in 1994.

- = Detection limit not reported because analyte was detected in all samples.

Table 2-16
PAHs: Sample Distribution and Frequency of Detection at South Landfill (1994)
Number of detects/samples analyzed

Analyte	Composite (Surface and Subsurface) Samples	Discrete (Subsurface Only) Samples
Individual PAHs	8/8	4/6
Total PAHs	14/16	3/16

Table 2-17
Surface cPAH Concentrations at South Landfill (mg/kg) (1994)

Compound	Maximum Concentration	Upper 95% UCL
Benzo(a)anthracene	100	49
Benzo(a)pyrene	110	49
Benzo(b)fluoranthene	160	78
Benzo(k)fluoranthene	54	24
Chrysene	110	56
Dibenzo(a,h)anthracene	20	9.4
Indeno(1,2,3-cd)pyrene	67	32

Note:

UCL = upper confidence limit.

Results based on samples collected in 1994.

Table 2-18
South Landfill Surface Soil Analytical Results (1997)

Report Class	Analyte	Units	SL-SB006 6/18/97	SL-SB012 6/18/97	SL-SB018 6/18/97	SL-SB024 6/18/97	SL-SB030 6/18/97	SL-SB036 6/18/97	SL-SB042 6/18/97	SL-SB048 6/18/97	SL-SB054 6/18/97	SL-SB060 6/18/97
CONV	Fluoride By 300.0	mg/kg	940 D	250 D	300 D	280 D	180 D	410 D	350 D	470 D	1200 D	1600 D
CONV	Fluoride By 340.1/340.2	mg/kg	18000 [J]	9100 [J]	14000 [J]	12000 [J]	8700 [J]	15000 [J]	15000 [J]	6900 [J]	6600 [J]	6200 [J]
CONV	Fluoride, Gl Extraction	mg/kg	3670	1400	3230	3020	1700	3880	3180	2850	5940	3870
CONV	Cyanide, Total	mg/kg	3.73	7.85	4.76	2.84	2.79	4.05	3.15	2.37	3.16	1.47
M-TOTAL	Aluminum	mg/kg	33900	21600	28900	29000	20800	29900	34100	16600	37200	17000
M-TOTAL	Antimony	mg/kg	3.6	2.8 U	6.3	6	3 U	4.1	3.6	2.8 U	4.1	2.9 U
M-TOTAL	Arsenic	mg/kg	8.2	9.6	21.1	14.4	14.8	19.5	19	11.3	24.2	6.1
M-TOTAL	Barium	mg/kg	131 [J]	91.9 [J]	127 [J]	121 [J]	113 [J]	100 [J]	95.6 [J]	59.5 [J]	152 [J]	52.5 [J]
M-TOTAL	Beryllium	mg/kg	6 [J]	3 [J]	3.5 [J]	3.4 [J]	2 [J]	3.4 [J]	3.5 [J]	1.6 [J]	3.5 [J]	0.68 [J]
M-TOTAL	Cadmium	mg/kg	2.8	2.6	3.9	5.2	2.7	4.4	3.8	1.4	3.3	1.1
M-TOTAL	Chromium	mg/kg	58.7	43.8	63	129	49.5	83.6	119	30.3	98.1	25
M-TOTAL	Copper	mg/kg	3700 [J]	2510 [J]	2100 [J]	3950 [J]	2000 [J]	5190 [J]	3650 [J]	1240 [J]	4610 [J]	641 [J]
M-TOTAL	Lead	mg/kg	344 [J]	123 [J]	227 [J]	126 [J]	148 [J]	135 [J]	173 [J]	181 [J]	432 [J]	63.1 [J]
M-TOTAL	Mercury	mg/kg	0.2	0.09	0.08	0.22	0.35	0.11	0.12	0.06 U	0.12	0.06 U
M-TOTAL	Nickel	mg/kg	105	112	140	199	109	212	192	90	286	89.4
M-TOTAL	Selenium	mg/kg	1.2 U	1.1 U	1.2 U	1.2 U	1.2 U	2.7	1.4	1.1 U	2	1.1 U
M-TOTAL	Silver	mg/kg	1.2 U	1.1 U	1.2 U	1.9	1.2 U	1.6	1.2	1.1 U	1.2 U	1.1 U
M-TOTAL	Thallium	mg/kg	1.2 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.2 U	1.1 U	1.2 U	1.1 U
M-TOTAL	Vanadium	mg/kg	79	75.1	100	123	80.2	120	142	71.3	172	102
M-TOTAL	Zinc	mg/kg	172	145	231	261	211	215	162	66.9	148	48.1
BNA	2-Methylnaphthalene	mg/kg	3.1 U	73 U	31 U	7.9 U	7.9 U	15 U	19 U	7.5 U	16 U	3.7 U
BNA	Acenaphthene	mg/kg	0.75 J	24 J	7.8 J	2.2 J	1.5 J	2.5 J	4.8 J	2.4 J	8.8 J	1.7 J
BNA	Acenaphthylene	mg/kg	3.1 U	73 U	31 U	7.9 U	7.9 U	15 U	19 U	7.5 U	16 U	3.7 U
BNA	Anthracene	mg/kg	1.3 J	50 J	10 J	3.1 J	3.2 J	4.1 J	7.4 J	2.8 J	9.5 J	2.1 J
BNA	Benzo(a)Anthracene	mg/kg	9.8	330	78	21	29	39	55	24	59	16
BNA	Benzo(a)Pyrene	mg/kg	11	370	91	27	31	50	72	35	82	25
BNA	Benzo(b)Fluoranthene	mg/kg	21	480	130	38	60	86	120	44	100	26
BNA	Benzo(G,H,I)Perylene	mg/kg	6.6	190	46	18	18	25	35	16	43	12
BNA	Benzo(k)Fluoranthene	mg/kg	11	290	83	27	28	47	62	25	49	15
BNA	Chrysene	mg/kg	14	400	97	28	42	52	67	28	73	18
BNA	Dibenzo(a,h)Anthracene	mg/kg	3 J	71 J	21 J	8.7	7.5 J	12 J	18 J	9.7	19	5.3
BNA	Fluoranthene	mg/kg	13	530	110	28	32	51	82	31	76	22
BNA	Fluorene	mg/kg	3.1 U	8.8 J	31 U	1.2 J	7.9 U	15 U	2.9 J	1.1 J	4.7 J	0.87 J
BNA	Indeno(1,2,3-Cd)Pyrene	mg/kg	7.4	200	55	23	21	31	46	24	48	14
BNA	Naphthalene	mg/kg	3.1 U	73 U	31 U	7.9 U	7.9 U	15 U	19 U	7.5 U	16 U	3.7 U
BNA	Phenanthrene	mg/kg	6.4	230	46	15	14	20	38	15	45	12
BNA	Pyrene	mg/kg	11	450	92	26	29	41	59	24	63	18

Table 2-18
South Landfill Surface Soil Analytical Results (1997)

Report Class	Analyte	Units	SL-SB006 6/18/97	SL-SB012 6/18/97	SL-SB018 6/18/97	SL-SB024 6/18/97	SL-SB030 6/18/97	SL-SB036 6/18/97	SL-SB042 6/18/97	SL-SB048 6/18/97	SL-SB054 6/18/97	SL-SB060 6/18/97
PEST/PCB	Aroclor 1016	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1221	mg/kg	0.79 U	1.5 U	7.9 U	4 U	1.6 U	3.8 U	3.9 U	3.8 U	1.6 U	1.5 U
PEST/PCB	Aroclor 1232	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1242	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1248	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1254	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1260	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1262	mg/kg	0.39 U	0.73 U	3.9 U	2 U	0.79 U	1.9 U	1.9 U	1.9 U	0.78 U	0.75 U
PEST/PCB	Aroclor 1268	mg/kg	0.54 P	1.8 P	24 P	1.6 P	1.1 P	6	2.1	2	3.2	0.75 U

U = The compound was analyzed for but not detected above method detection limits.

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

D = Results reported at more than one dilution factor.

P = The difference in PCB concentrations exceeded 25 percent. The lower value is reported, per EPA CLP reporting standards.

Results based on samples collected in 1997.

GI extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be available.

Table 2-19
Metals Concentrations in Surface Soil, South Landfill (1997)

Metal	Maximum Concentration Detected (mg/kg)	Location of Maximum Detection	Detection Frequency
Aluminum	37200	SB054	10/10
Antimony	6.3	SB018	6/10
Arsenic	24.2	SB054	10/10
Barium	152 J	SB054	10/10
Beryllium	3.5 J	SB054	10/10
Cadmium	5.2	SB024	10/10
Chromium	129	SB024	10/10
Copper	5190 J	SB036	10/10
Lead	432 J	SB054	10/10
Mercury	0.35	SB030	9/10
Nickel	286	SB054	10/10
Selenium	2.7	SB036	3/10
Silver	1.9	SB024	3/10
Vanadium	172	SB054	10/10
Zinc	261	SB024	10/10

Notes:

J = The reported value is estimated, since it is below the method reporting limit for the analysis.
 Results based on samples collected in 1997.

Table 2-20
PAH Concentrations in Surface Soil, South Landfill (1997)

Compound	Maximum Concentration (mg/kg) ^a	Minimum Detected Concentration (mg/kg) ^b	Frequency of Detection
2-methylnaphthalene	ND	ND	0/10
Acenaphthene	24 J	0.75 J	10/10
Acenaphthylene	ND	ND	0/10
Anthracene	50 J	1.3 J	10/10
Benzo(a)anthracene ^c	330	9.8	10/10
Benzo(a)pyrene ^c	370	11	10/10
Benzo(b)fluoranthene ^c	480	21	10/10
Benzo(g,h,i)perylene	190	6.6	10/10
Benzo(k)fluoranthene ^c	290	11	10/10
Chrysene ^c	400	14	10/10
Dibenzo(a,h)anthracene ^c	71 J	3 J	10/10
Fluoranthene	530	13	10/10
Fluorene	8.8 J	1.1 J	6/10
Indeno(1,2,3-cd)pyrene ^c	200	7.4	10/10
Naphthalene	ND	ND	0/10
Phenanthrene	230	6.4	10/10
Pyrene	450	11	10/10

^a All maximum concentrations were found in sample SL-SB012.

^b All minimum detected concentrations were found in sample SL-SB006, except fluorene. The minimum detected concentration of fluorene was found in sample SL-SB048; fluorene was not detected in sample SL-SB006.

^c Indicates carcinogenic PAH.

ND = Not detected above the method detection limit.

J = The reported value is estimated, since it is below the method reporting limit for the analysis. Results based on samples collected in 1997.

Table 2-21
South Landfill Surface Water Analytical Results (1997)

Page 1 of 2

Report Class	Analyte	Units	SL-SW01 4/28/97	SL-SW02 5/9/97
CONV	Fluoride by 300.0	mg/L	42.1	59.3
CONV	Cyanide, Amenable	mg/L	0.02 U	NA
CONV	Cyanide, Total	mg/L	0.042	0.026
CONV	Hardness, Total	mg/L	20	17
M-DISS	Aluminum	mg/L	5.44	6.26
M-DISS	Antimony	mg/L	0.005 U[J]	0.005 UJ
M-DISS	Arsenic	mg/L	0.004 U	0.004 U
M-DISS	Barium	mg/L	0.02 U	0.02 U
M-DISS	Beryllium	mg/L	0.0046	0.0059
M-DISS	Cadmium	mg/L	0.002 U	0.002 U
M-DISS	Chromium	mg/L	0.01 U	0.01 U
M-DISS	Copper	mg/L	0.0268	0.022
M-DISS	Lead	mg/L	0.001 U	0.001 U
M-DISS	Mercury	mg/L	0.0002 U	0.0002 U
M-DISS	Nickel	mg/L	0.04 U	0.04 U
M-DISS	Selenium	mg/L	0.005 U[J]	0.005 U
M-DISS	Silver	mg/L	0.003 U	0.003 U
M-DISS	Thallium	mg/L	0.002 U[J]	0.002 U
M-DISS	Vanadium	mg/L	0.02 U	0.02 U
M-DISS	Zinc	mg/L	0.05 U	0.05 U
M-TOTAL	Aluminum	mg/L	5.4	5.61
M-TOTAL	Antimony	mg/L	0.005 U[J]	0.005 UJ
M-TOTAL	Arsenic	mg/L	0.004 U	0.004 U
M-TOTAL	Barium	mg/L	0.02 U	0.02 U
M-TOTAL	Beryllium	mg/L	0.0049	0.0054
M-TOTAL	Cadmium	mg/L	0.002 U	0.002 U
M-TOTAL	Chromium	mg/L	0.01 U	0.01 U
M-TOTAL	Copper	mg/L	0.0308	0.0269
M-TOTAL	Lead	mg/L	0.001 U	0.001 U
M-TOTAL	Mercury	mg/L	0.0002 U	0.0002 U
M-TOTAL	Nickel	mg/L	0.04 U	0.04 U
M-TOTAL	Selenium	mg/L	0.005 U	0.005 U
M-TOTAL	Silver	mg/L	0.003 U	0.003 U
M-TOTAL	Thallium	mg/L	0.002 U[J]	0.002 U
M-TOTAL	Vanadium	mg/L	0.02 U	0.02 U

Table 2-21
South Landfill Surface Water Analytical Results (1997)

Page 2 of 2

Report Class	Analyte	Units	SL-SW01 4/28/97	SL-SW02 5/9/97
M-TOTAL	Zinc	mg/L	0.05 U	0.05 U
BNA	2-Methylnaphthalene	mg/L	0.01 U	0.01 U
BNA	Acenaphthene	mg/L	0.01 U	0.01 U
BNA	Acenaphthylene	mg/L	0.01 U	0.01 U
BNA	Anthracene	mg/L	0.01 U	0.01 U
BNA	Benzo(a)Anthracene	mg/L	0.01 U	0.01 U
BNA	Benzo(a)Pyrene	mg/L	0.01 U	0.01 U
BNA	Benzo(b)Fluoranthene	mg/L	0.01 U	0.01 U
BNA	Benzo(G,H,I)Perylene	mg/L	0.01 U	0.01 U
BNA	Benzo(k)Fluoranthene	mg/L	0.01 U	0.01 U
BNA	Chrysene	mg/L	0.01 U	0.01 U
BNA	Dibenzo(a,h)Anthracene	mg/L	0.01 U	0.01 U
BNA	Fluoranthene	mg/L	0.01 U	0.01 U
BNA	Fluorene	mg/L	0.01 U	0.01 U
BNA	Indeno(1,2,3-Cd)Pyrene	mg/L	0.01 U	0.01 U
BNA	Naphthalene	mg/L	0.01 U	0.01 U
BNA	Phenanthrene	mg/L	0.01 U	0.01 U
BNA	Pyrene	mg/L	0.01 U	0.01 U
PEST/PCB	Aroclor 1016	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1221	mg/L	0.002 U	0.002 U
PEST/PCB	Aroclor 1232	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1242	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1248	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1254	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1260	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1262	mg/L	0.001 U	0.001 U
PEST/PCB	Aroclor 1268	mg/L	0.001 U	0.001 U

Notes:

NA = not analyzed.

U = The compound was analyzed for but not detected.

J = The reported value is estimated, since it is below the method reporting limit for the analysis.

Results based on data collected in 1997.

Table 2-22
Summary of Investigations at Fairview Farms

Investigation	Description	Key Findings	Reference
Removal Site Assessment (1994)	Two soil samples collected in eastern portion of central drainage. Samples analyzed for cyanide, fluoride, metals, PAHs, PCBs, and TOC.	Cyanide, fluoride and PAHs were detected in both samples. PCB aroclor 1260 detected in both samples. TPH and metals were also detected.	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendices (CH2M HILL, 1995)</i>
Supplemental Data Gathering (1995)	<p>Soil: Total of 20 surface soil samples collected on 2 east-west transects. Samples also collected at 6 inches and 12 inches below the ground surface at every other location.</p> <p>Vegetation: samples collected at soil sample locations. Also samples collected of leaves, branches, and berries from berry bushes in NW corner of Fairview Farms.</p> <p>Brick and Debris Pile: Four brick and debris piles sampled both surface and native soil.</p> <p>Dredge Spoil: 2 dredge spoil samples collected along bank of Salmon creek, both surface and within pile.</p> <p>Drainage Ditch: soil and surface water collected at 2 locations in central drainage ditch</p> <p>All soil samples analyzed for cyanide, fluoride, metals, PAHs, and PCBs (vegetation analyzed for PCBs only if PCBs were found in adjacent soils). Water samples analyzed for fluoride, metals, and PAHs only.</p>	<p>Soil: No PCBs detected; Cyanide detected in 1 sample. Metals found generally above background levels. PAHs detected in low concentrations. No spatial or depth trend in distribution of constituents.</p> <p>Vegetation: No PAHs or cyanide were detected. One sample contained fluoride near detection limit. Metal concentrations generally lower than corresponding soil concentrations.</p> <p>Brick and Debris: Cyanide and PCBs not detected. PAHs detected in 1 of 8 samples. Some metals detected at concentrations similar to soils. Note: brick and debris piles were moved to south landfill in Fall 1996.</p> <p>Dredge Spoils: No cyanide detected. PAHs detected in one surface sample. PCBs detected in 1 of 3 samples slightly above detection limit. Metal concentrations at or below range of Fairview Farms soil concentrations.</p> <p>Drainage Ditch Soil: Fluoride and cyanide detected in 2 of 4 samples. Two samples analyzed for PCBs and TPH; both detected. Metal concentrations comparable to surrounding soil concentrations.</p> <p>Drainage Ditch Surface Water: Fluoride and metals detected at low concentrations. No PAHs were detected.</p>	<i>Technical Memorandum DS No. 16: Data Summary for the Soil and Debris Areas Addendum to the RI/FS Work Plan (CH2M HILL, 1997)</i>

Table 2-23
Summary of Detected Constituents in Soil for Fairview Farms (1994 and 1995)

Constituent	Minimum Detection	Maximum Detection	Maximum Detection Sample ID	Frequency of Detection
Inorganic Compounds (mg/kg)				
Cyanide, total	2.1	2.1	FF-SB02-0000-0	1/30
Fluoride, total	210	620	FF-SB11-0000-0	30/30
Metals (mg/kg)				
Aluminum	14100	28300	FF-SB10-0010-0	30/30
Arsenic	2.8	9.01	FF-SB04-0005-0	30/30
Barium	112	215	FF-SB10-0010-0	30/30
Beryllium	0.54	0.87	FF-SB10-0010-0	30/30
Cadmium	0.54	1.12	FF-SB16-0000-0	3/30
Calcium	3780	8120	FF-SB10-0010-0	30/30
Chromium	17.4	31.4	FF-SB10-0010-0	30/30
Cobalt	6.1	15.1	FF-SB10-0010-0	30/30
Copper	25.1	40.2	FF-SB13-0000-0	30/30
Iron	17900	35500	FF-SB10-0010-0	30/30
Lead	10.6	34.3	FF-SB02-0000-0	30/30
Magnesium	3950	7780	FF-SB10-0010-0	30/30
Manganese	130	758	FF-SB10-0010-0	30/30
Mercury	ND	ND	NA	0/30
Nickel	16.2	23.6	FF-SB02-0005-0	30/30
Potassium	590	2900	FF-SB06-0000-0	30/30
Selenium	1	1.1	FF-SB06-0000-0	2/30
Silver	ND	ND	NA	0/30
Sodium	419	1390	FF-SB08-0005-0	30/30
Thallium	ND	ND	NA	0/30
Vanadium	44.8	73.2	FF-SB02-0010-0	30/30
Zinc	53.3	189	FF-SB12-0000-0	30/30
PAHs (mg/kg)				
Acenaphthene	ND	ND	NA	0/30
Acenaphthylene	ND	ND	NA	0/30
Anthracene	ND	ND	NA	0/30
Benzo(a)anthracene	0.3	0.6	FF-SB02-0000-0	14/30
Benzo(a)pyrene	0.3	0.7	FF-SB02-0000-0	7/30
Benzo(b)fluoranthene	0.3	1.1	FF-SB02-0000-0	12/30
Benzo(g,h,i)perylene	0.4	0.7	FF-SB02-0000-0	5/30
Benzo(k)fluoranthene	0.3	0.4	FF-SB11-0000-0	8/30
Chrysene	0.3	0.8	FF-SB03-0000-0	15/30
Dibenzo(a,h)anthracene	ND	ND	NA	0/30
Fluoranthene	0.3	0.7	FF-SB02-0000-0	6/30
Fluorene	ND	ND	NA	0/30
Indeno(1,2,3-c,d)pyrene	0.3	0.5	FF-SB02-0000-0	4/30
Naphthalene	ND	ND	NA	0/30
Phenanthrene	0.3	0.5	FF-SB11-0000-0	4/30
Pyrene	0.3	0.8	FF-SB02-0000-0	9/30
Total PCBs (mg/kg)			NA	0/20

Notes:

NA = not applicable; constituent not detected.

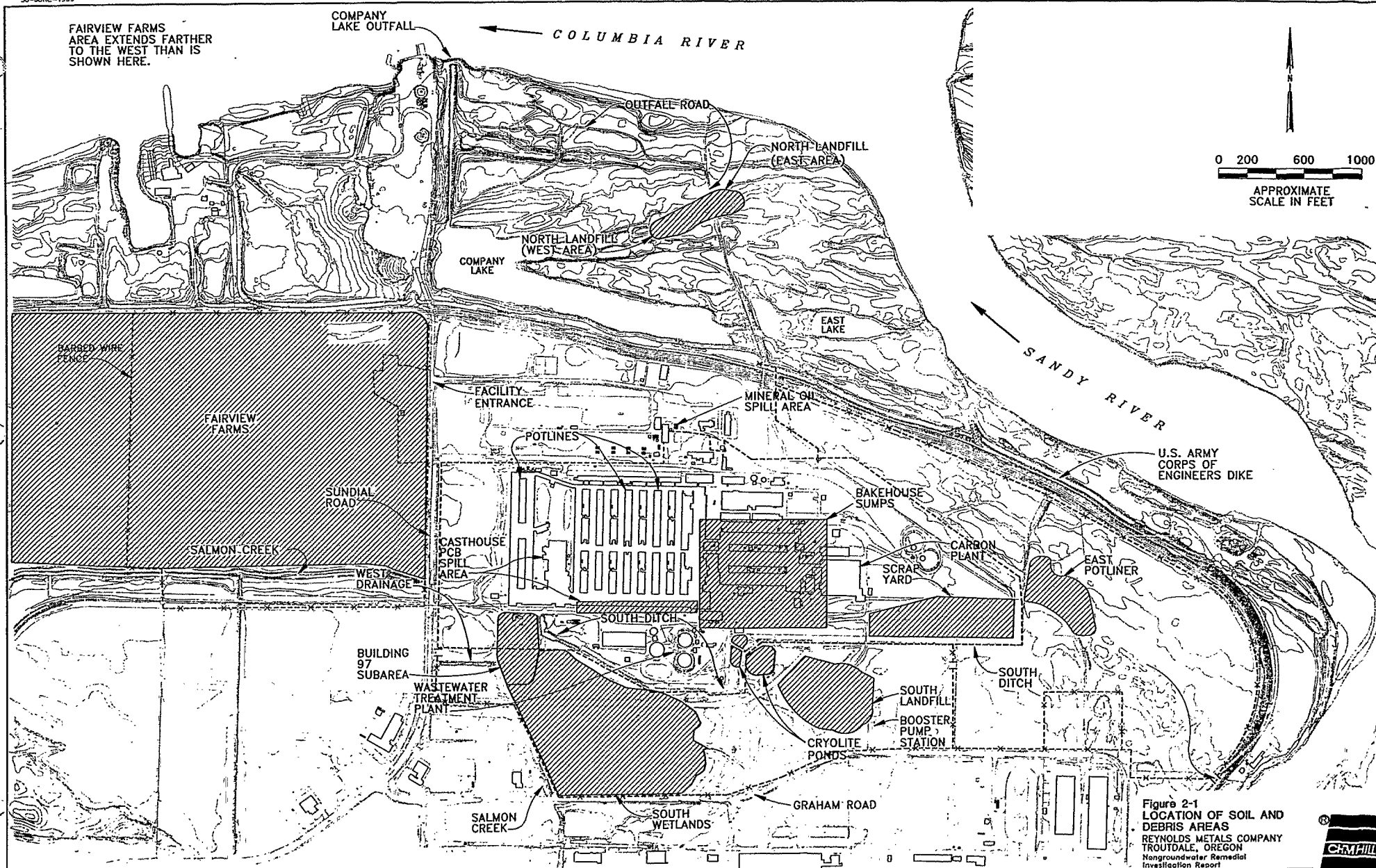
Data based on samples collected in 1994 and 1995.

ND = not detected above the method detection limit.

Table 2-24
Summary of the Investigation at the Mineral Oil Spill Area

Investigation	Description	Key Findings	Reference
Supplemental Data Gathering (1995)	Soil samples collected from varying depths (0 to 5 ft bgs) from nine Geoprobe borings. All samples analyzed for PCBs; selected samples analyzed for TPH. Two soil samples taken from 2 ft bgs near the tanks were analyzed for SVOCs, TPH, and VOCs.	PCBs detected in 11 of 21 samples ranging from 0.3 to 2.1 mg/kg. TPH detected in 7 of 9 samples. One PAH detected in one sample. No VOCs or SVOCs detected. Most detections were found in the bermed area.	<i>Addendum No. 1 to Draft Current Situation Summary: Mineral Oil Spill Area</i> (CH2M HILL, November 13, 1996)

Figures



1-JULY-1999

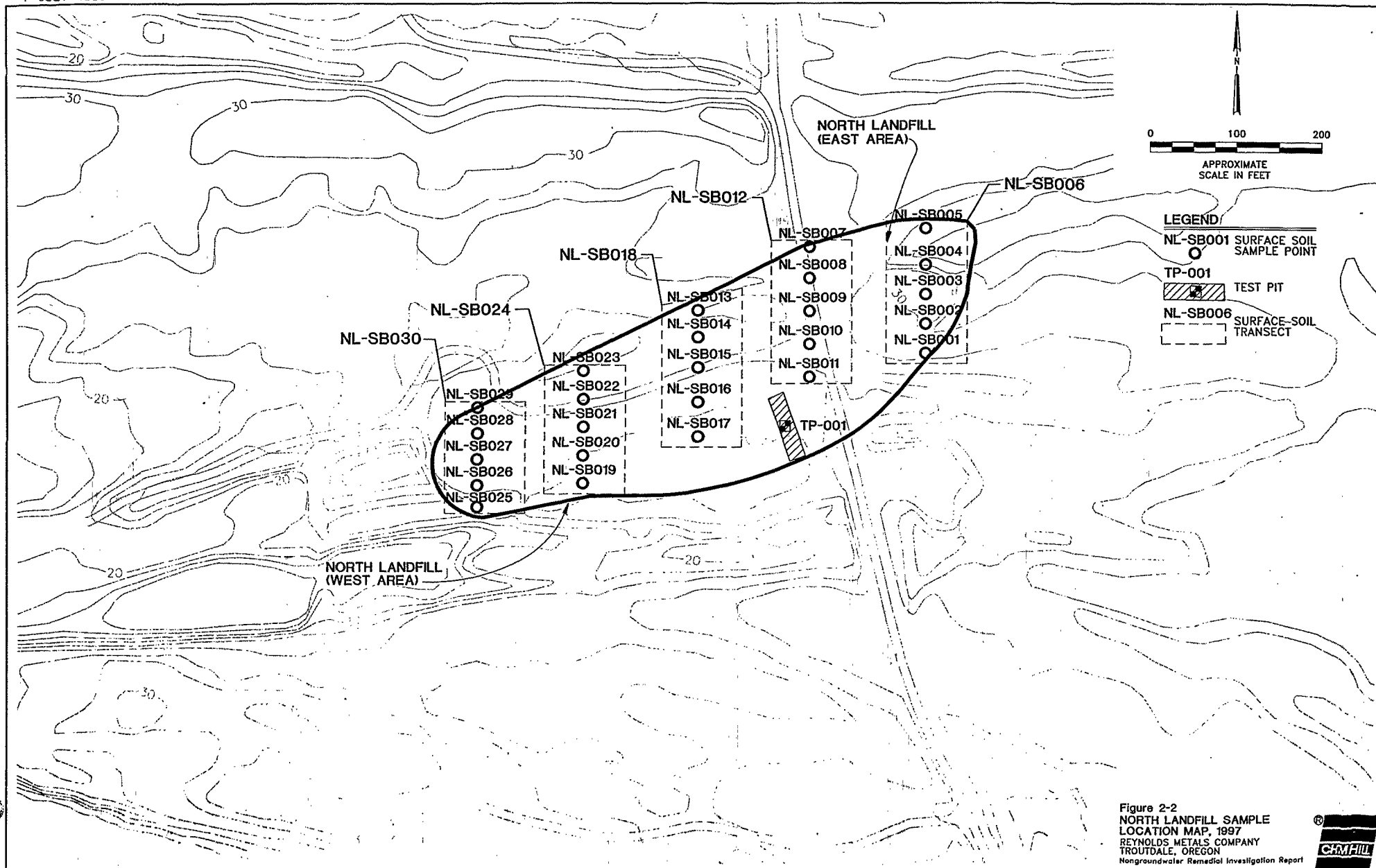
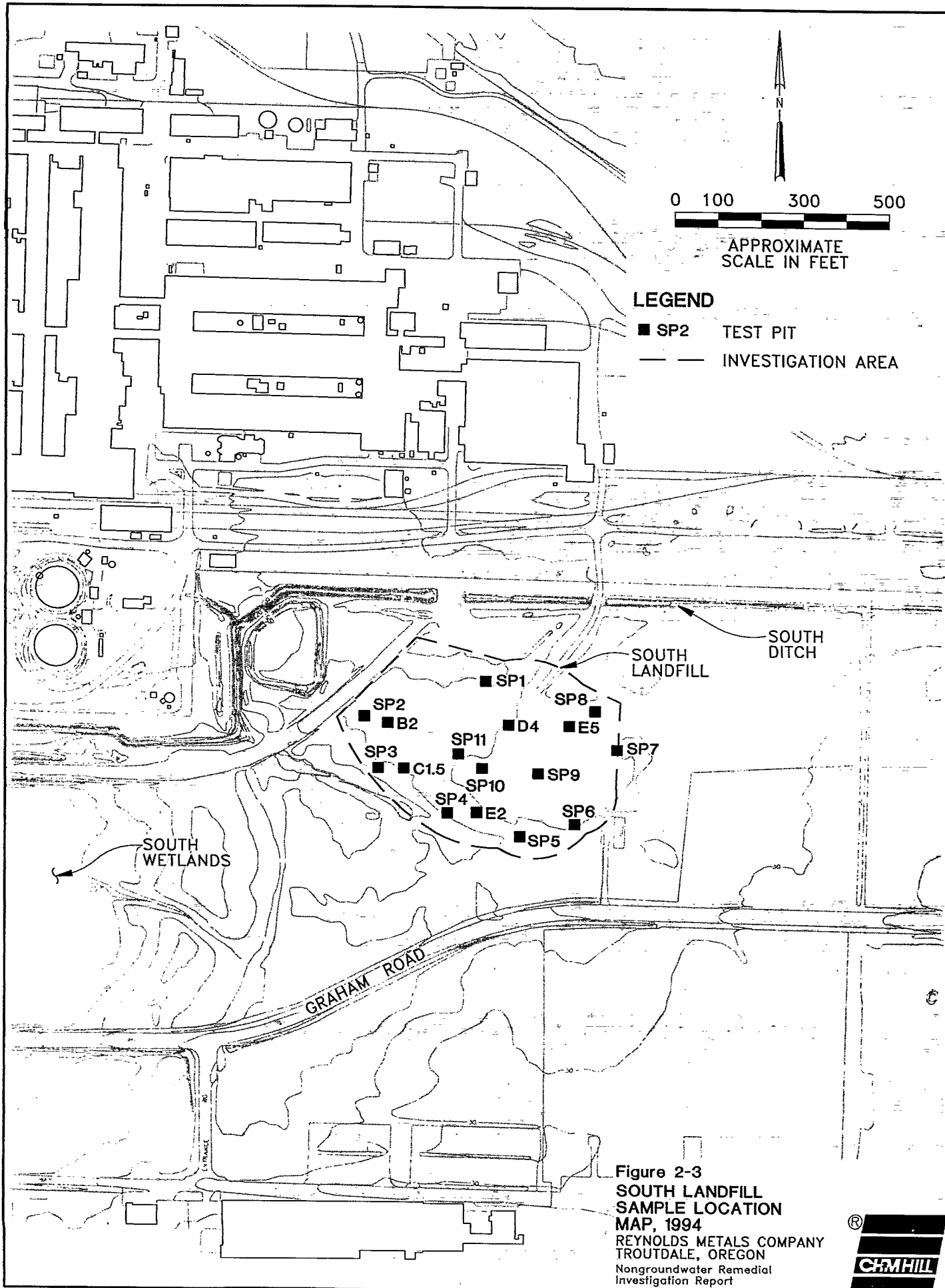
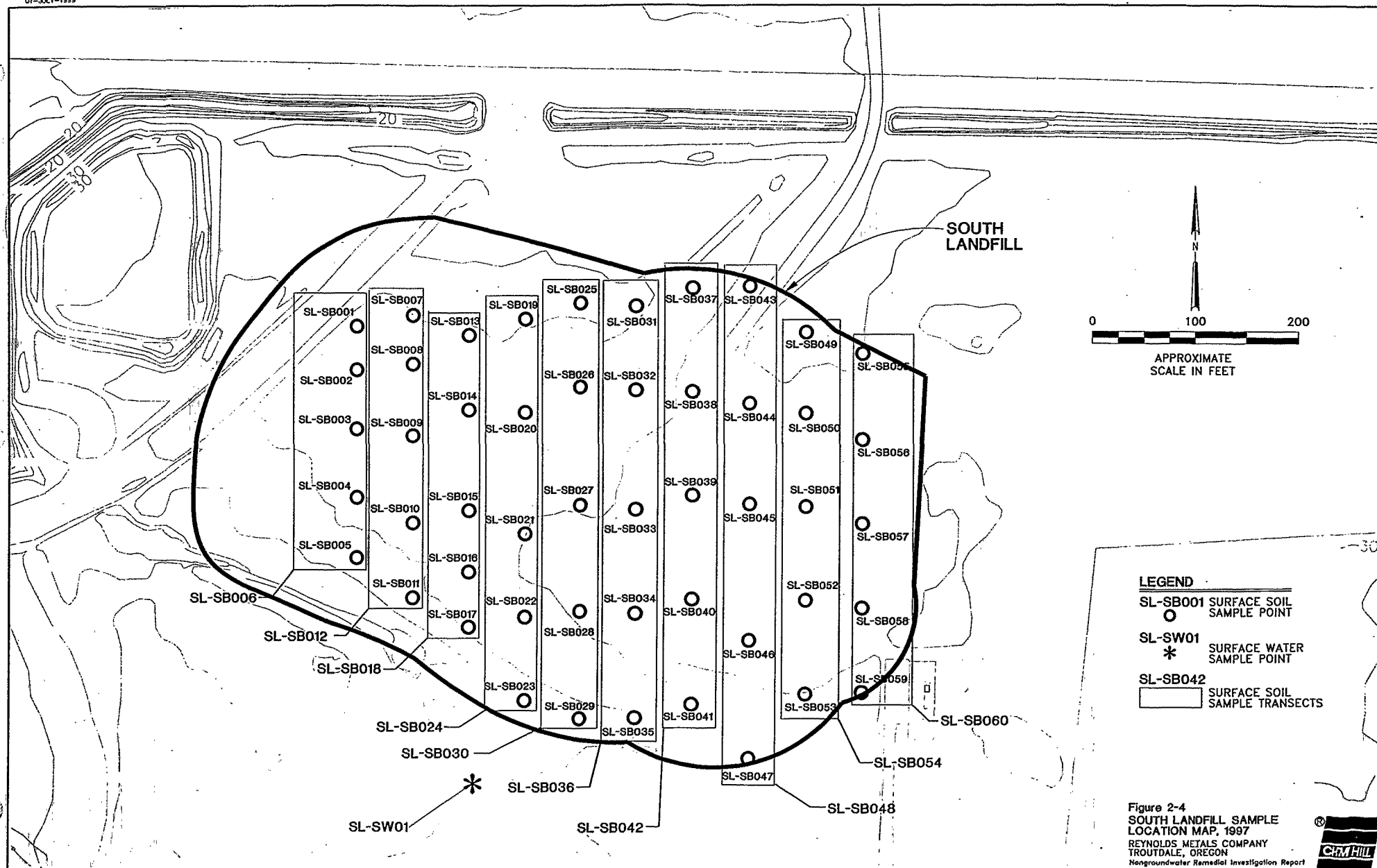


Figure 2-2
NORTH LANDFILL SAMPLE
LOCATION MAP, 1997
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial Investigation Report





01-JULY-1999



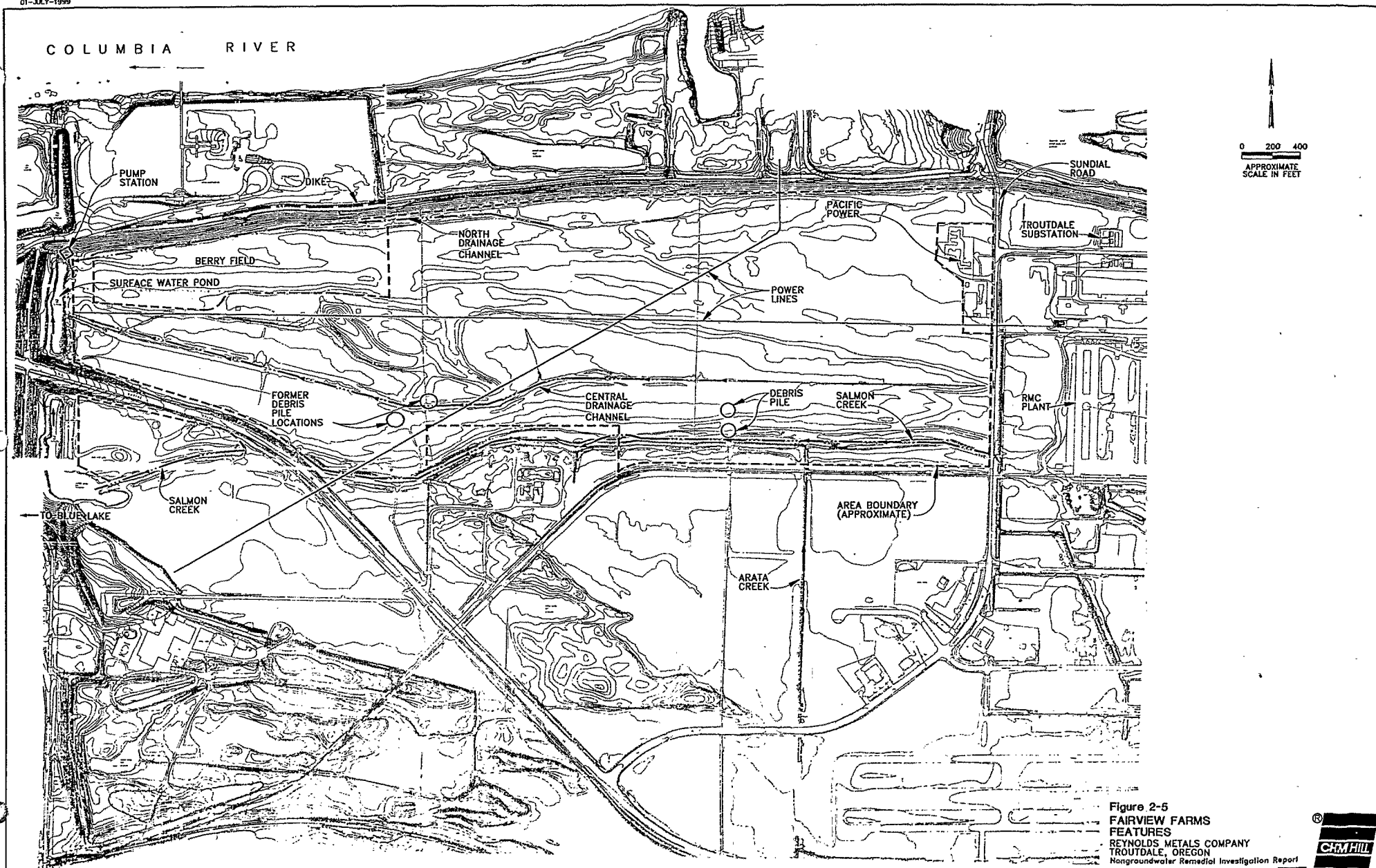
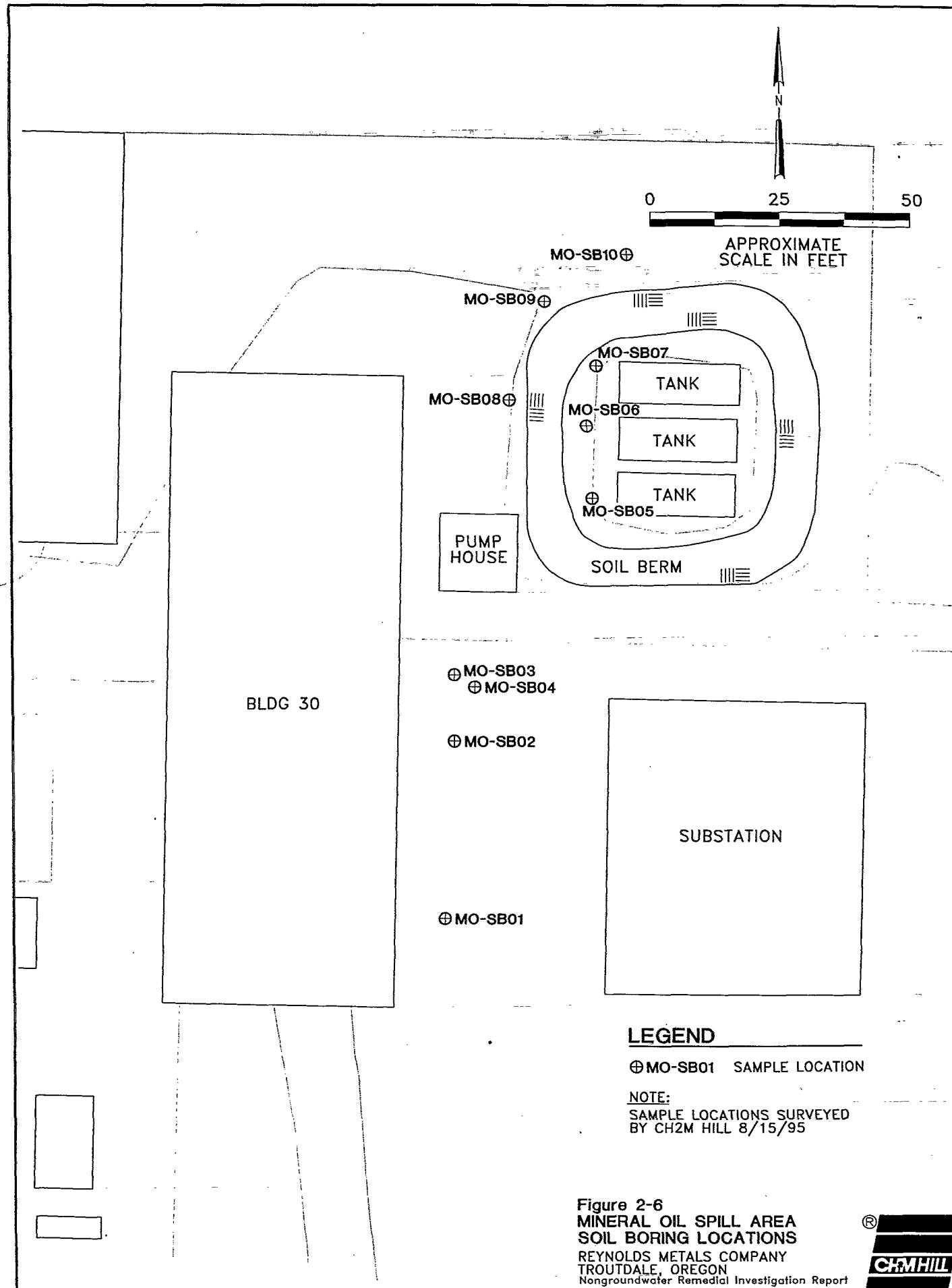
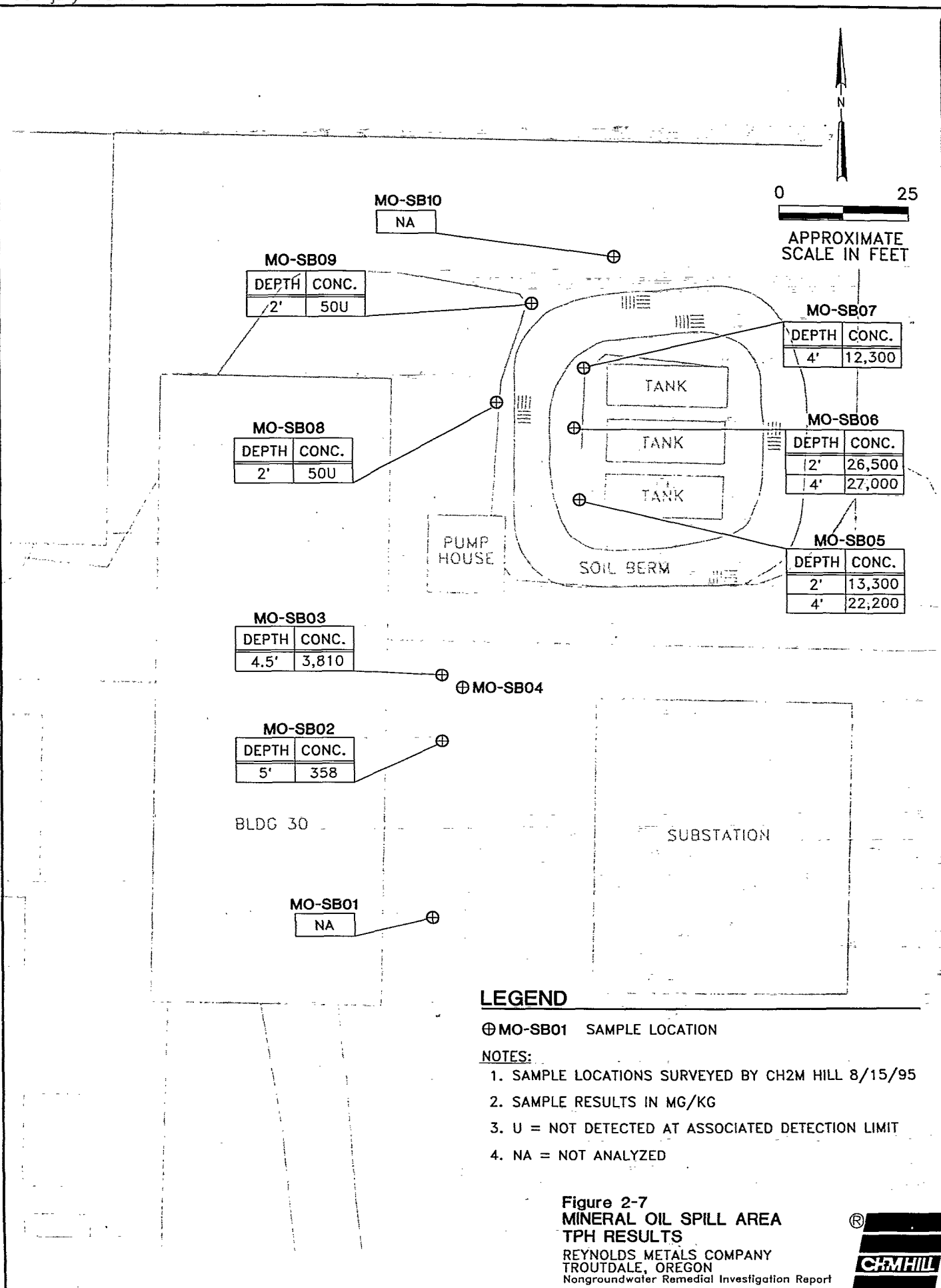


Figure 2-5
 FAIRVIEW FARMS
 FEATURES
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report







SECTION 3

South Wetlands

SECTION 3

South Wetlands

This section summarizes the findings of remedial investigations conducted at south wetlands since RMC began its pre-RI/FS evaluations in 1994. The south wetlands area includes West Drainage, a ditch that conveys surface water from south wetlands to Salmon Creek. A summary of investigations at West Drainage is included in this section. An overview of Salmon Creek investigations is presented in Section 5 of this document.

Information on groundwater in the south wetlands area is presented in the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999). Detailed information relating to south wetlands and West Drainage can be found in the documents below.

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary* (CH2M HILL, May 10, 1995)
- *Memorandum WP No. 13: Revised West Drainage Stormwater Monitoring Plan* (CH2M HILL, November 22, 1995)
- *Technical Memorandum DS No. 8: South Wetlands Study Area Supplemental Data-Gathering Summary* (CH2M HILL, January 3, 1996)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Addendum to West Drainage Stormwater Monitoring Plan Memorandum WP No. 13* (CH2M HILL, April 17, 1996)
- *Draft South Wetlands Addendum to the RI/FS Work Plan (SWLA)* (CH2M HILL, May 8, 1996)
- *Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality* (CH2M HILL, February 12, 1997)
- *Review Draft—Evaluation of Bioaccessibility of Inorganic Constituents in Soil for South Wetlands Ecological Risk Assessment* (CH2M HILL, May 13, 1998a)
- *Review Draft—Ecological Exposure Assumptions for Company Lake and South Wetlands* (CH2M HILL, May 13, 1998b)

When the *Draft South Wetlands Addendum to the RI/FS Work Plan (SWLA)* was first drafted, a two-part data summary was planned. Part 1 was to report the results for soil, surface water, and groundwater quality, and Part 2 was to provide an evaluation of the interactions between surface water and groundwater. Part 2 of this proposed data summary was expanded to include a larger portion of the south plant and became Appendix A of the *Draft Groundwater Remedial Investigation Report*.

3.1 Description of South Wetlands

South wetlands is located south of the RMC reduction facility. The approximately 23-acre area is made up of the Building 97 subarea, the main wetlands area, and West Drainage. RMC owns the northern two-thirds portion of the wetlands, and the Port of Portland owns the southern third. Figure 3-1 is a facility map showing the location of south wetlands. Figure 3-2 shows physical features in the area and sample locations referred to later in this section.

Surface water forms ponds in south wetlands only during the rainy season, when groundwater elevations are high. The primary sources of water flowing into south wetlands are listed below:

- Direct precipitation
- Groundwater discharge
- Stormwater/groundwater flows entering from the overflow from the old Salmon Creek channel east of the wetlands (Inlet-3 in Figure 3-2)
- Stormwater entering from a culvert connected to the stormwater ditch south of Graham Road
- Stormwater entering from a street catch basin near the eastern edge of the wetlands north of Graham Road

In addition to these flows, overflow from South Ditch into south wetlands via an overflow weir has occasionally occurred during unusually heavy storms when South Ditch flows have exceeded the pumping capacity to Company Lake.

West Drainage is evaluated with south wetlands because it may be affected by surface water discharges from south wetlands. West Drainage drains into Salmon Creek, which ultimately discharges to the Columbia River.

South wetlands was used as a settling pond for wastewater discharged from the processing facilities between 1941 and 1965. According to aerial photographs, the former discharge pond extended just south of Graham Road and north into the existing Building 97 subarea. Construction and operation of this pond required alteration and channelization of Salmon Creek, which used to flow north around the eastern and northern boundaries of the wetlands.

Wetland discharges before 1947 are understood to have been low, and according to aerial photographs, may not have produced a significant area of ponded water. Flows from south wetlands before 1947 were discharged to Salmon Creek. From 1947 to 1966, flows from south wetlands were discharged to Company Lake. Use of the settling pond was discontinued in 1965, when wastewater flows were routed via South Ditch to Company Lake. Shortly thereafter, sand fill was placed in the Building 97 subarea so that a wet scrubber system could be installed. The wet scrubber has since been removed, but the concrete pad (north of the fence) on which it was located remains.

Wastewater discharges into south wetlands are considered to be the primary source of constituents detected in the area. Historically, there were three wastewater/stormwater discharge inlets into south wetlands, identified through aerial photographs (Figure 3-2):

- A northwestern outfall, identified in the SWLA as Inlet-1 (primarily some wastewater; possibly some facility stormwater)
- A north-central outfall, identified as Inlet-2, just to the northeast of sample location WP-02 (primarily wastewater; possibly some facility stormwater)
- The overflow from the old Salmon Creek channel east of the wetlands, identified as Inlet-3 (primarily stormwater from the facility and areas east of the plant site; some wastewater)

Currently, the area supports primarily wetland-type plants (for example, reed canarygrass) and is densely vegetated. The U.S. Fish and Wildlife Service (USFWS) has classified south wetlands as a Palustrine Emergent Wetland as part of its National Wetland Inventory (NWI). The COE has made no jurisdictional determination of south wetlands.

3.2 Summary of Investigations at South Wetlands

Several field efforts have been conducted in south wetlands since 1994. These investigations have included collection and analysis of surface and subsurface soil samples in south wetlands, and of surface water and sediment samples in West Drainage and Salmon Creek. Table 3-1 presents a summary of the investigations.

3.4 Nature and Extent of Chemical Constituents at South Wetlands

A discussion of the nature and extent of constituents at south wetlands is presented in the SWLA. The nature and extent of chemical constituents at south wetlands and West Drainage is summarized below.

3.4.1 South Wetlands

The primary source of constituents in the main south wetlands area is process residue solids deposited from past wastewater discharges. The process residue exists in a layer approximately 4 to 17 inches in depth in near-surface soil, except in the Building 97 subarea and the southern portion (primarily on Port of Portland property), where it is thinner or nonexistent. The estimated volume of process residue is approximately 48,000 cubic yards.

Four soil layers were noted in the shallow subsurface soil: process residue, a silt layer, organically rich material, and silt with clay layers. Constituent concentrations are greatest in the top process residue layer. The silt layer underlying the process residue was not frequently analyzed; therefore, it is uncertain how much leaching into this layer may have occurred. The two bottom layers showed low to nondetectable concentrations of constituents. However, in areas with no visible process residue (primarily on Port of Portland property), there were still detectable concentrations of some constituents (such as cyanide, PCBs, and PAHs in surface soil).

Constituents detected at elevated levels in south wetlands include:

- Fluoride
- PCBs

- PAHs
- Metals (copper, mercury, vanadium)
- Cyanide

An initial risk evaluation was conducted during development of the SWLA for the purpose of identifying additional data needs to complete both the baseline risk assessment and the nature and extent of chemical constituents. As a result, it was determined that existing data were sufficient for PAHs and cyanide but that additional data were required for fluoride, PCBs, and metals in three "areas of uncertainty" (AOUs) shown in Figure 3-2. (One sample of a tar-like material in the subsurface soil was also analyzed for PAHs.) These data were collected during summer 1996.

Figures 3-3 (fluoride), 3-4 (PCBs), 3-5 (copper), 3-6 (mercury), and 3-7 (vanadium) are based on data collected from 1994 to 1996. Figure 3-8 (total PAHs) is based on the data existing prior to the data collected in 1996 for the SWLA.

The distribution of cyanide appears to be fairly random. It was below the level of detection in some central locations, and the highest concentration (114 mg/kg) was in the southeast (SW-16), where the process residue layer was absent. Consequently, no contour map was prepared for cyanide data.

Table 3-2 compares concentrations of fluoride, copper, vanadium, mercury, and total PCBs in samples collected before the SWLA (prior to 1996) with concentrations found in samples collected for the SWLA in 1996.

Analysis of the distribution of fluoride, copper, mercury, and vanadium supports the current understanding that the source of elevated constituents in south wetlands is past wastewater/stormwater discharges along the northern and eastern boundaries.

PCBs in the three AOUs were generally below 10 mg/kg. No steep gradient was detected to indicate a point source of PCBs in AOU-2; instead, it appears that PCBs are distributed unevenly within AOU-2.

Additional data were collected in 1997 to support an assessment of bioavailability for the ecological baseline risk assessment. This included a chemical specific bioavailability assessment. The results of the study are detailed in *Review Draft—Evaluation of Bioaccessibility of Inorganic Constituents in Soil for South Wetlands Ecological Risk Assessment*. The evaluation is included in *Review Draft—Ecological Exposure Assumptions for Company Lake and South Wetlands*.

As expected, the distribution of constituents in the Building 97 subarea differs from the distribution in south wetlands. The primary source of constituents in the Building 97 subarea is liquids from the wet scrubber system previously located on the concrete pad. Aerial photographs indicate that wet scrubber liquids drained east, south, and west from the concrete pad. Constituent concentrations were found to be greatest near the pad. None of the process residue typical of south wetlands was found under the sand fill.

Constituents investigated within the Building 97 subarea include fluoride and PCBs. Fluoride was detected (maximum of 34,000 mg/kg) at all depths and locations, while PCBs were found only in the surface soil near the concrete pad and not in the southern portion of the subarea. In addition, an area just south of the concrete pad (SW-SB02) was found to have

detectable PAHs within the upper 3.5 feet and elevated concentrations of metals at a depth of 2 to 3.5 feet.

3.4.2 West Drainage

Constituents present in south wetlands are expected to be observed in West Drainage because it receives discharges (groundwater and surface water) from the main wetlands area. West Drainage is generally dry in the summer, except for some backflow from Salmon Creek. Because south wetlands is well-vegetated and surface water flow rates are low, sediment transport into West Drainage is not expected to be significant.

Existing data for West Drainage indicate that sediments have detected concentrations of fluoride (3,600 mg/kg), aluminum (19,000 mg/kg), iron (14,000 mg/kg), PCBs (Aroclor 1260 at 2.8 mg/kg), and PAHs. Most metals, PCBs, and PAHs were at concentrations generally similar to south wetlands surface soil concentrations. Surface water analysis indicated that fluoride, aluminum, iron, total petroleum hydrocarbons for diesel (TPH-D), and several metals were above laboratory reporting limits. Table 3-3 is a comparison of historical surface water data collected in West Drainage and Salmon Creek, and data collected for the SWLA. A complete set of West Drainage data, as well as data collected for Salmon Creek, are contained in *Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality*.

3.5 Fate and Transport Issues at South Wetlands

Leaching of constituents from the process residue appears to be the most significant mechanism for transport of dissolved constituents to subsurface soil and shallow groundwater. Elevated levels of fluoride and metals have been detected in shallow groundwater samples. Chemical constituents appear to have migrated to shallow groundwater as a result of rainfall infiltration or direct contact with the water table. PAHs and PCBs have low solubilities and do not readily migrate in soil. They have not been detected in shallow groundwater except at SW-WP02, where dissolved PCB concentrations near the solubility limit were detected, apparently the result of the temporary well point construction method. This wellpoint was removed with the agencies' concurrence in 1996.

Constituents present in south wetlands are expected to occur in West Drainage, which receives runoff from south wetlands. However, surface water monitoring in Salmon Creek above and below the confluence with West Drainage did not show consistently higher constituent concentrations in the downstream samples (data presented in *Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1- Soil, Surface Water, and Groundwater Quality*). Constituent transport into West Drainage via surface water or groundwater occurs during high groundwater periods; West Drainage is generally dry in the summer except for some backflow from Salmon Creek. Because south wetlands is well-vegetated, sediment transport into West Drainage is not expected to be significant.

Tables

Table 3-1
Summary of Investigations at South Wetlands

Investigation	Description	Key Findings	References
Removal Site Assessment (1994)	Subsurface and/or surface soil samples collected from eight locations: two within the Building 97 subarea and six within south wetlands.	Detected fluoride, cyanide, pesticides, PAHs, PCBs, and metals in samples from south wetlands; detected fluoride and PAHs in samples from the southern portion of the Building 97 subarea (metals and TPH not analyzed).	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
West Drainage Sample Collection (1995)	Surface water and sediment samples collected from two locations in West Drainage.	Detected fluoride, cyanide, PCBs, PAHs, and metals in the sediment samples; detected fluoride, diesel-related hydrocarbons, and several metals in surface water samples.	<i>Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary</i> (CH2M HILL, May 10, 1995)
Supplemental Data Gathering (1995)	Soil samples collected from 17 locations: two within the Building 97 subarea and 15 within south wetlands.	Detected fluoride, cyanide, PCBs, PAHs, and metals at most locations in surface soil; showed that constituents are concentrated in the process residue layer.	<i>Technical Memorandum DS No. 8: South Wetlands Study Area Supplemental Data-Gathering Summary</i> (CH2M HILL, January 3, 1996)
West Drainage Stormwater Monitoring Program (June 1996)	Surface water samples collected at West Drainage weir, upstream and downstream of West Drainage confluence in Salmon Creek, from inflows into south wetlands, and from ponded water at SW-WP02 under baseline and storm flow conditions. Flow rate monitored at West Drainage weir.	<p>West Drainage: Fluoride detected in all base flow samples, CN detected in one sample. Metals typically above detection limit. No PAHs, PCBs, or TPH detected. Fluoride detected in stormwater samples, no CN, PAHs, PCBs, or TPH detected. Metals detected similar to base flow.</p> <p>Salmon Creek: Fluoride detected in stormwater samples, increased concentrations downstream of the confluence with West Drainage during first storm event but similar concentrations during second event. No CN, PCBs, or TPH detected. Low-level PAHs detected both upstream and downstream of West Drainage. Metals detected higher downstream during first storm event but no difference between upstream and downstream concentrations during second event.</p> <p>Inflows to south wetlands: Fluoride and CN detected in Old Salmon Creek. Detected metals</p>	<i>Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality</i> (CH2M HILL, February 12, 1997)

Table 3-1
Summary of Investigations at South Wetlands

Investigation	Description	Key Findings	References
		generally same as West Drainage. PAHs detected at Graham Road catch basin. No PCBs or TPH detected. No PCBs detected in surface water near SW-WP02 (PCBs detected in groundwater at SW-WP02) or south of railroad grade.	
Data Collection for <i>South Wetlands Addendum to the RI/FS Work Plan</i> (1996)	<p>Soil: Samples collected from 24 locations: six surface samples in area of uncertainty-1 (AOU-1), two surface and 12 sets of surface/subsurface samples in AOU-2, four (three surface and one surface/subsurface) samples in AOU-3. Samples in AOU-2 were analyzed for total PCBs only. Samples in AOU-1 and AOU-3 analyzed for total PCBs, total fluoride, soluble fluoride, and metals [copper (Cu), vanadium (V), and Mercury (Hg)]. Two samples in AOU-3 were analyzed for PAHs and TPH.</p> <p>Groundwater: Collected additional groundwater quality data for PCBs downgradient of AOU-2, additional data for PCBs within south wetlands, near WP-02, shallow groundwater characteristics in north-central and southwestern portions of south wetlands.</p>	<p>AOU-1: Fluoride and PCBs detected in all samples. Cu and V detected at all locations. Hg detected at all but one location.</p> <p>AOU-2: PCBs detected at all locations in top process residue layer. PCBs also detected in subsurface at one location. Highest concentration found at location directly south of WP-02.</p> <p>AOU-3: Fluoride and PCBs detected at all locations. Cu and V detected in all samples. Hg detected in one sample.</p> <p>Groundwater: SW-WP02 was removed and a monitoring well (MW36-006) was installed near SW-WP02 to verify PCB concentrations in groundwater. No detectable PCB concentrations in any of the wells sampled. Previous detections in SW-WP02 were likely the result of the temporary well point construction method. Groundwater quality and groundwater/surface water interactions in the south portion of the facility are discussed in the <i>Draft Groundwater Remedial Investigation Report</i> (CH2M HILL, June 1999).</p>	<i>Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality</i> (CH2M HILL, February 12, 1997)
Bioavailability Investigation (1997)	Surface soil samples were collected and subjected to extraction procedures that simulated the digestive tract to determine what fraction of inorganic constituents might be biologically available.	The biologically available fractions of four inorganic constituents were found to be significantly less than 1.0 and were used in the intake equations for the ecological baseline risk assessment: aluminum (0.07), copper (0.46), fluoride (0.35), and vanadium (0.31).	<i>Review Draft—Evaluation of Bioaccessibility of Inorganic Constituents in Soil for South Wetlands Ecological Risk Assessment</i> (CH2M HILL, May 13, 1998)

Table 3-2
Comparison of Historical South Wetlands Surface Soil Data and Data Collected in 1996 for the SWLA

Analyte	AOU-1				AOU-2				AOU-3				Entire Study Area	
	1996 Data		Historical ^a		1996 Data		Historical ^b		1996 Data		Historical ^b		Historical ^c	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Fluoride (340.1/340.2)	1200	20000	14000	29000					320	10000		35000	150 UL	35000
Metals														
Copper	85.8	689	419	1010					24.6	505		359	28.4	1010
Mercury	0.2 U	1.45	1.13 K	2.11 K					0.2 U	0.22		3.16	0.2 U	3.16
Vanadium	57.5	748	702	1450					48	364		1000	53.8	1450
PCBs														
Total PCBs	0.3	11	5.22	10.1	0.3 U	42		45	0.3 U	6.1		10.6	0.3 U	10.6

All values in mg/kg.

^a Represents three samples collected in AOU-1 (collected in 1995).

^b Only one sample was taken during past studies in AOU-2 and AOU-3 (collected in 1994 and 1995).

^c Includes data from all of south wetlands study area (18 samples) (collected in 1994 and 1995).

J = estimated value.

K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.

U = Substance not detected. Value given is detection limit.

UL = The compound was analyzed for but not detected. Reported detection limit may be biased low. Actual detection limit is expected to be higher.

SWLA = Draft South Wetlands, Addendum to the RI/FS Work Plan (CH2M HILL, May 8, 1996).

AOU = area of uncertainty.

PCB = polychlorinated biphenyl.

Table 3-3

Comparison of Historical West Drainage and Salmon Creek Surface Water Data with Data Collected in 1996 for the SWLA

Analyte (mg/L)	West Drainage						Salmon Creek			
	1996 Base Flow		1996 Stormwater		Historical (1995)		1996		Historical (1994 and 1995)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Cyanide, Total	0.02 U	0.06 L		0.02 U		0.01 U		0.02 U		0.01 U
Fluoride (340.1/340.2)	12 L	18	5.4 L	20	18	18	0.25 U	0.66	0.5 U	1
Hardness, Total	30.9	42.8	20.4	85			33.2	47.1	57	61
Total Metals										
Aluminum	4.34	8.5	1.21	8.15	8.6	8.9	0.617	5.35	0.1 U	0.48
Antimony		0.005 U		0.005 U		0.005 U		0.005 U		0.005 U
Arsenic		0.004 U		0.004 U		0.004 U		0.004 U		0.004 U
Beryllium	0.00066	0.00099	0.0003 U	0.0012		0.02 U		0.0003 U		0.02 U
Cadmium	0.002 U	0.004 U		0.002 U	0.0003 U	0.0003		0.002 U		0.0003 U
Chromium		0.01 U		0.01 U		0.02 U		0.01 U		0.02 U
Copper	0.0459	0.0862	0.0166	0.118	0.08	0.09	0.003 U	0.0146		0.02 U
Iron	1.63	4.86	0.728	15.3	3.8	4.5	1.21	7.67	0.17	0.76
Lead	0.0013	0.0032	0.001 U	0.0045		0.004 U	0.002	0.0093		0.004 U
Mercury		0.0002 U	0.0002 U	0.00024		0.0005 U		0.0002 U		0.0005 U
Nickel	0.146	0.295	0.0628	0.328		0.26		0.04 U		0.05 U
Selenium		0.005 U		0.005 U		0.004 U		0.005 U		0.004 U
Silver	0.003 U	0.005 U		0.003 U		0.02 U		0.003 U		0.02 U
Thallium		0.002 U		0.002 U		0.004 U		0.002 U		0.004 U
Vanadium		0.0258	0.02 U	0.0644	0.05	0.06	0.02 U	0.024		0.02 U
Zinc		0.05 U		0.05 U			0.05 U	0.0712		0.05 U
PAHs										
Acenaphthene		0.0001 U		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.005
Acenaphthylene		0.0001 U		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.005 U
Anthracene		0.0001 U		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.005 U
Benzo(a)anthracene		0.0001 U		0.0001 U		0.0001 U		0.0001 U		0.0001 U
Benzo(a)pyrene		0.0001 U		0.0001 U		0.0001 U		0.0001 U		0.0001 U
Benzo(b)fluoranthene		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001	0.0001 U	0.00011
Benzo(g,h,i)perylene		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001		0.0001 U
Benzo(k)fluoranthene		0.0001 U		0.0001 U		0.0001 U		0.0001 U		0.0001 U
Chrysene		0.0001 U		0.0001 U		0.0001 U		0.0001 U		0.0001 U
Dibenzo(a,h)anthracene		0.0001 U		0.0001 U		0.0001 U		0.0001 U		0.0001 U
Fluoranthene		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001	0.0001 U	0.00011
Fluorene		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0002	0.0001 U	0.005 U
Indeno(1,2,3-cd)pyrene		0.0001 U		0.0001 U		0.0002 U		0.0001 U	0.0001 U	0.0002 U
Naphthalene		0.0001 U		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.005 U
Phenanthrene		0.0001 U		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.005 U
Pyrene		0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0002	0.0001 U	0.00013
TPH										
TPH (418.1)		10 U		10 U				10 U		
Diesel/Related (C12-C24)					0.3	0.7			0.3 U	0.3
Gasoline						0.1 U				0.2 U
Heavy Oil/Related (C24-C40)						0.5 U				1 U
PCB Screen										
Total PCBs		0.001 U		0.001 U		0.001 U		0.001 U		0.001 U

SWLA = Draft South Wetlands Addendum to the RI/FS Work Plan (CH2M HILL, May 8, 1996).

PAH = polynuclear aromatic hydrocarbon.

TPH = total petroleum hydrocarbon.

PCB = polychlorinated biphenyl.

L = Estimated value, may be biased low on basis of spike recovery results.

U = Substance not detected. Value given is detection limit.

Figures

01-JULY-1999

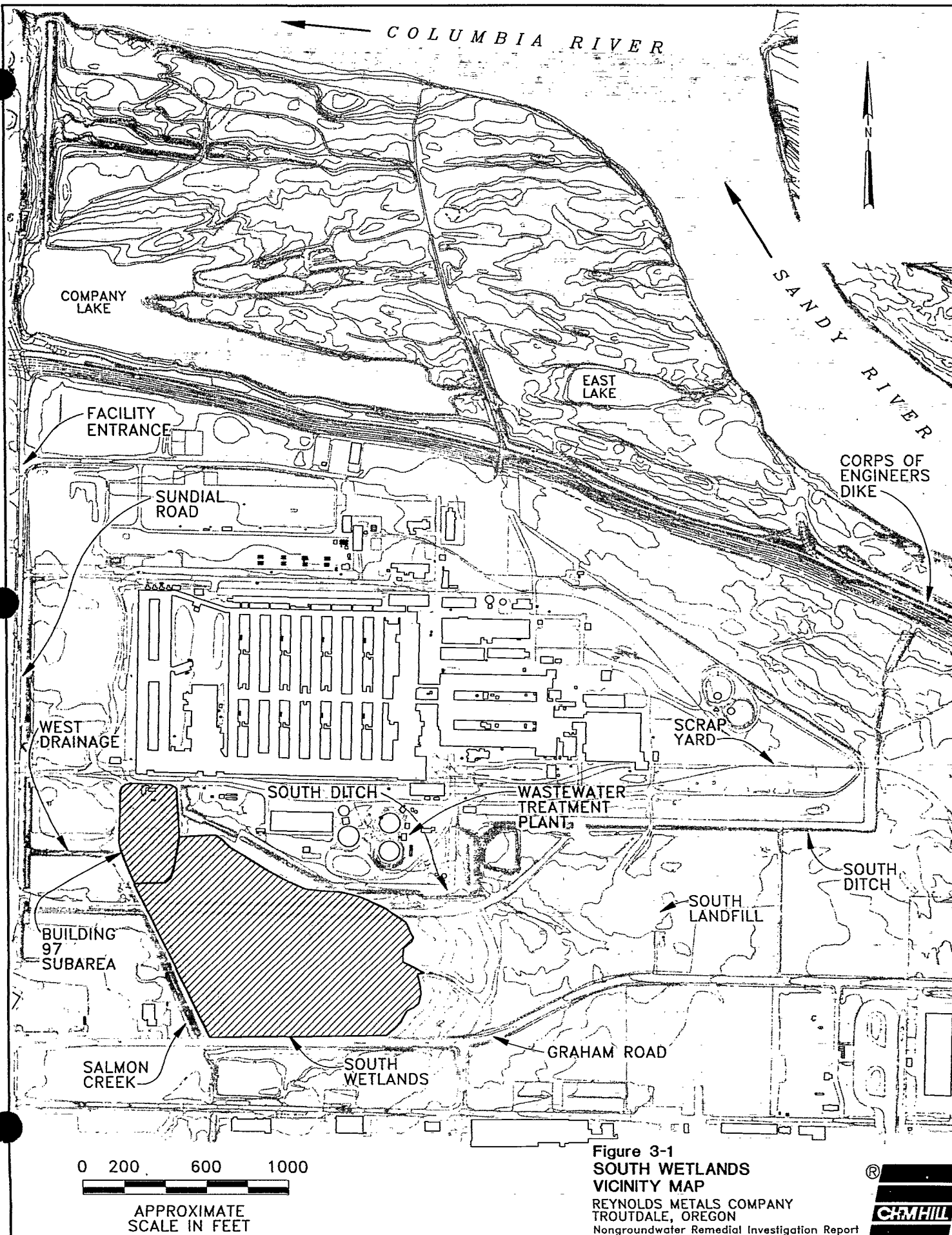


Figure 3-1
SOUTH WETLANDS
VICINITY MAP

REYNOLDS METALS COMPANY
TROUTDALE, OREGON

Nongroundwater Remedial Investigation Report



01-JUL-1999

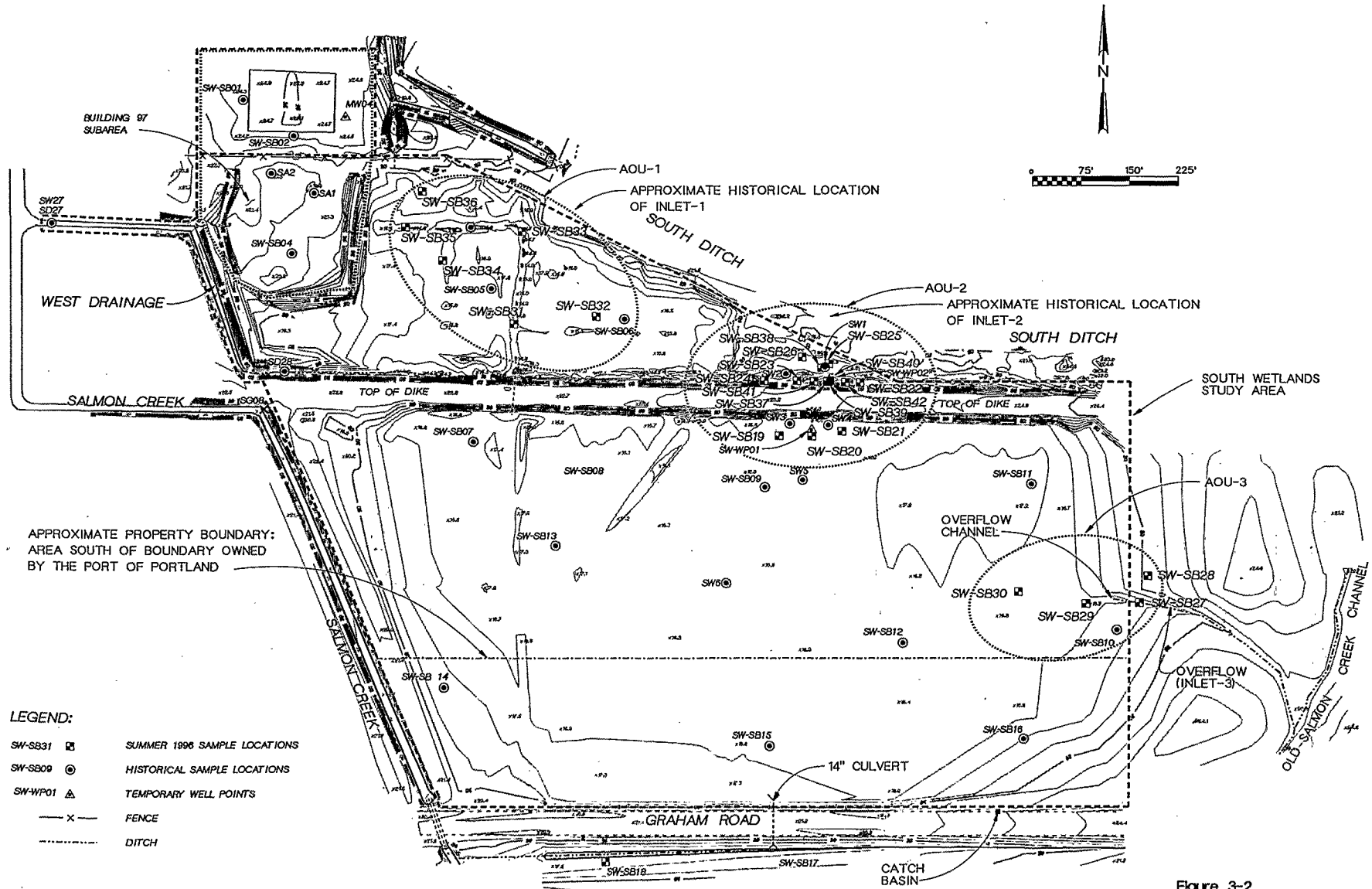


Figure 3-2
SOUTH WETLANDS AREA AND
SAMPLE LOCATION MAP
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report



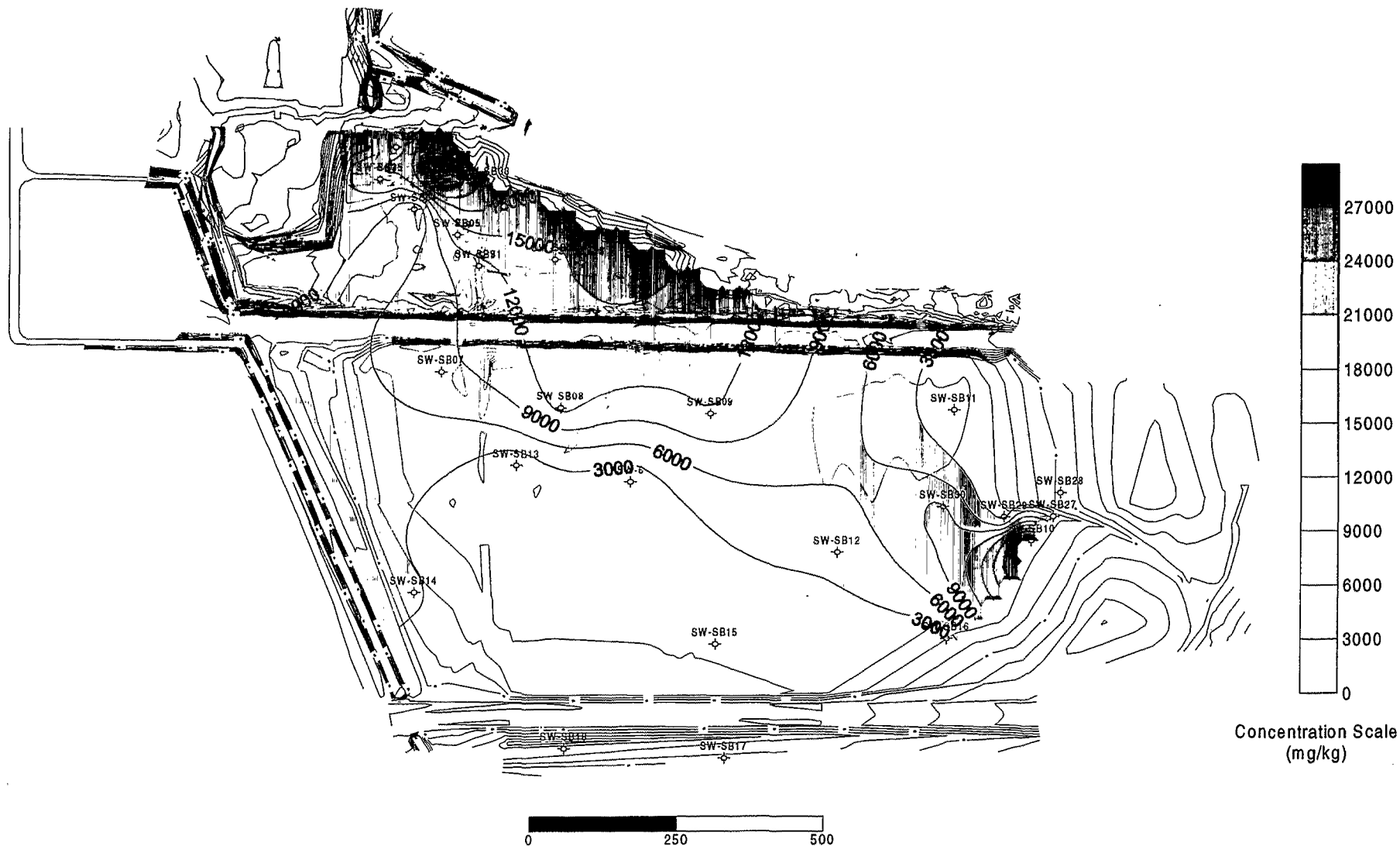


Figure 3-3
 FLUORIDE DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

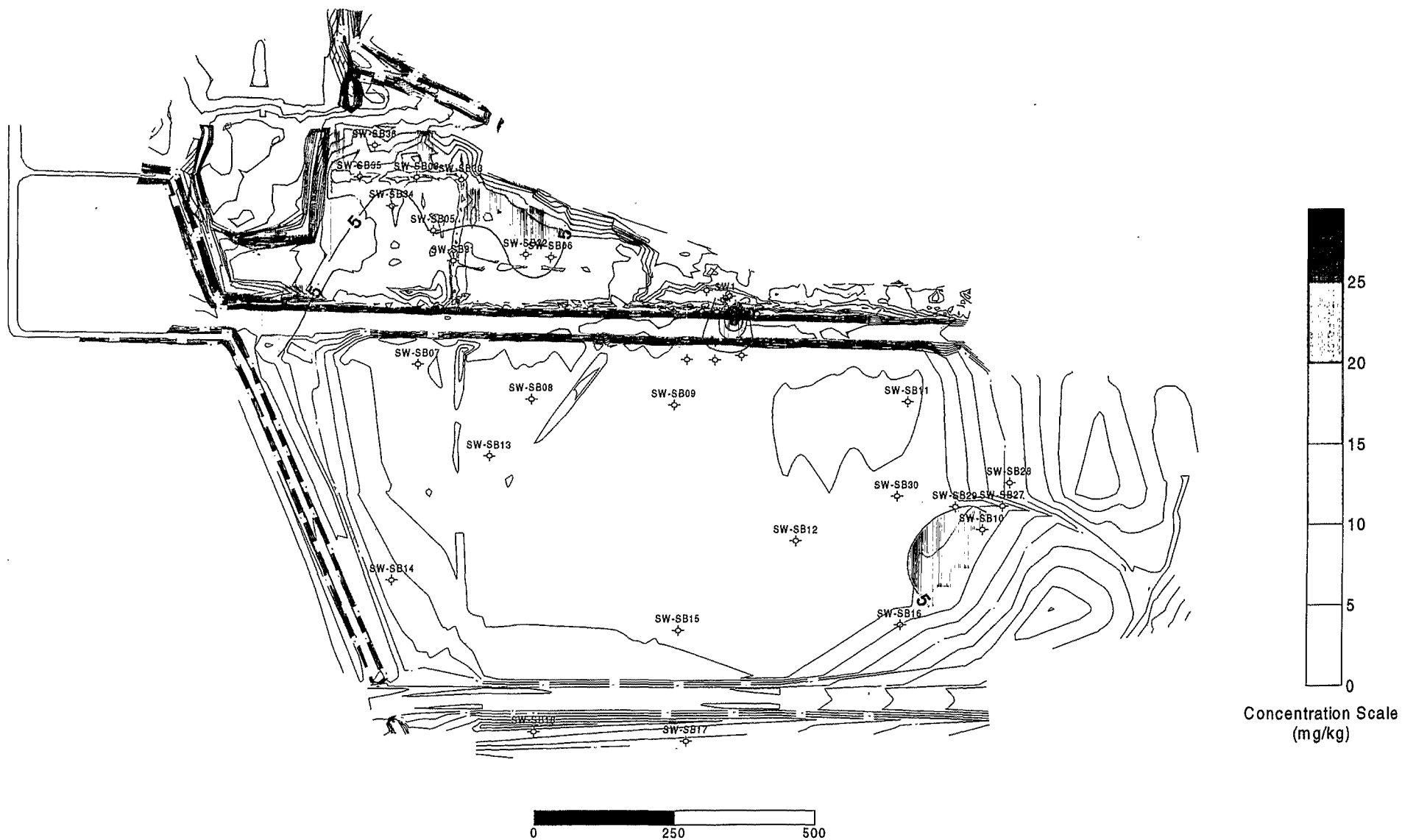


Figure 3-4
 TOTAL PCB DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

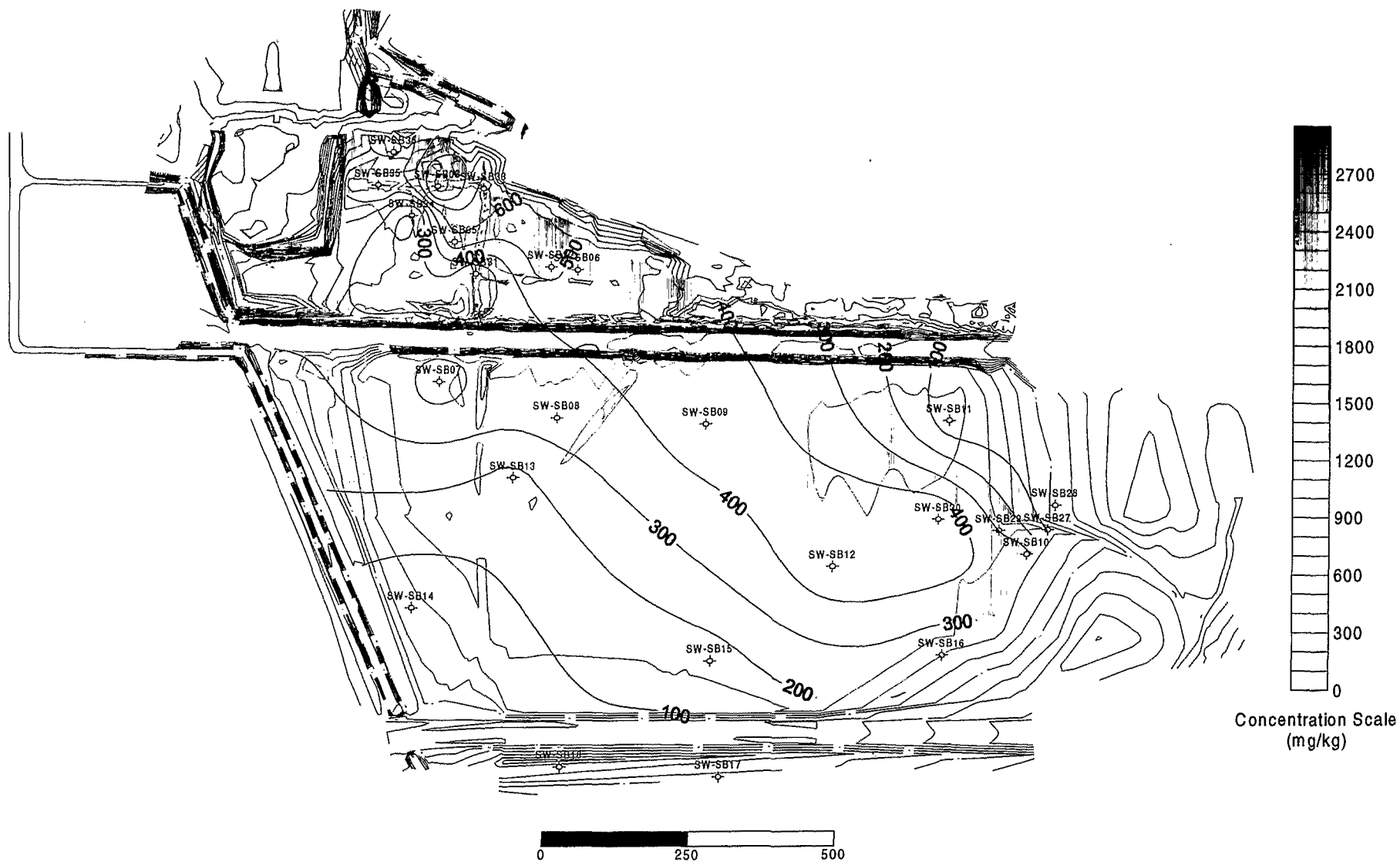


Figure 3-5
 COPPER DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

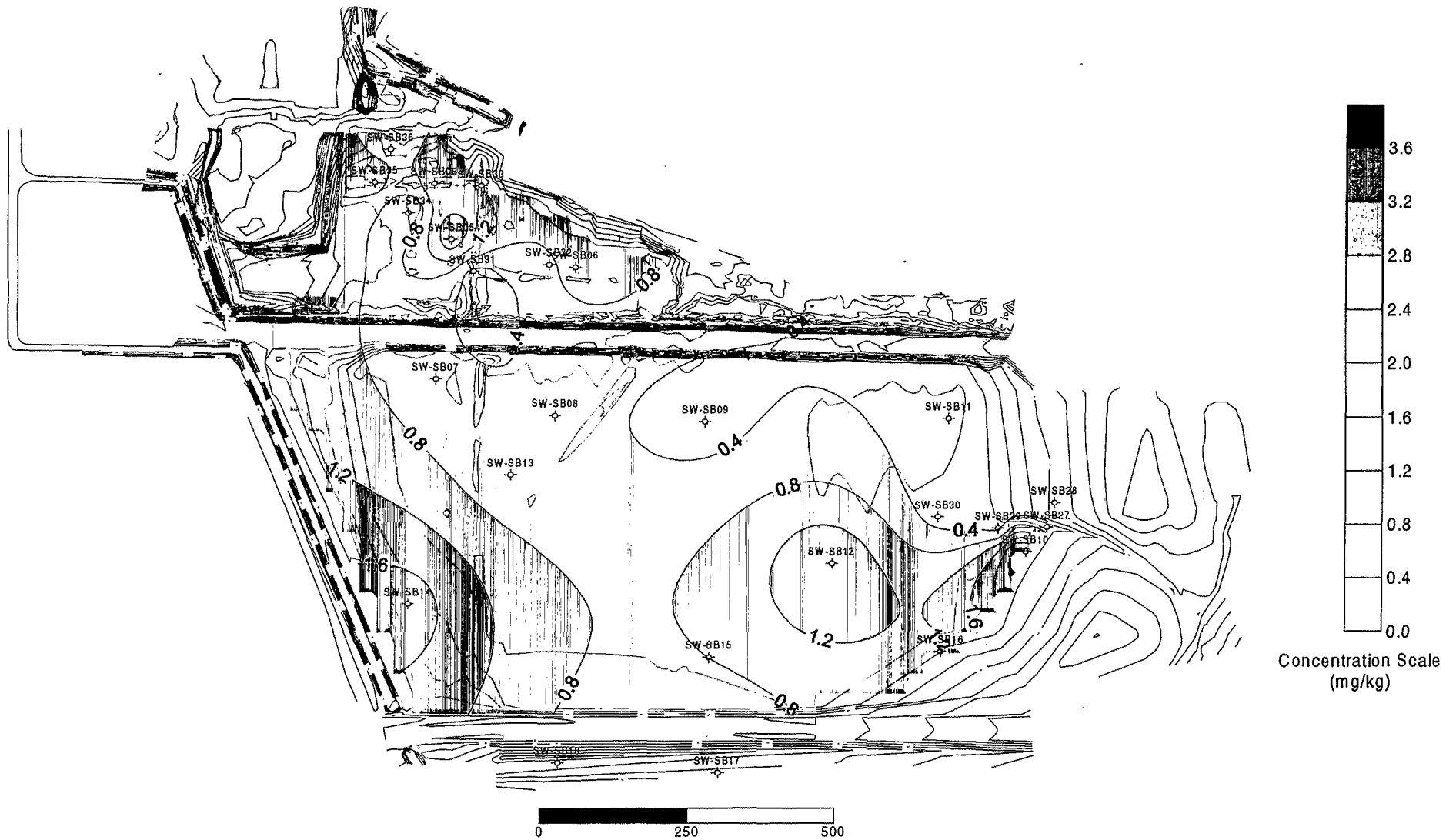


Figure 3-6
 MERCURY DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

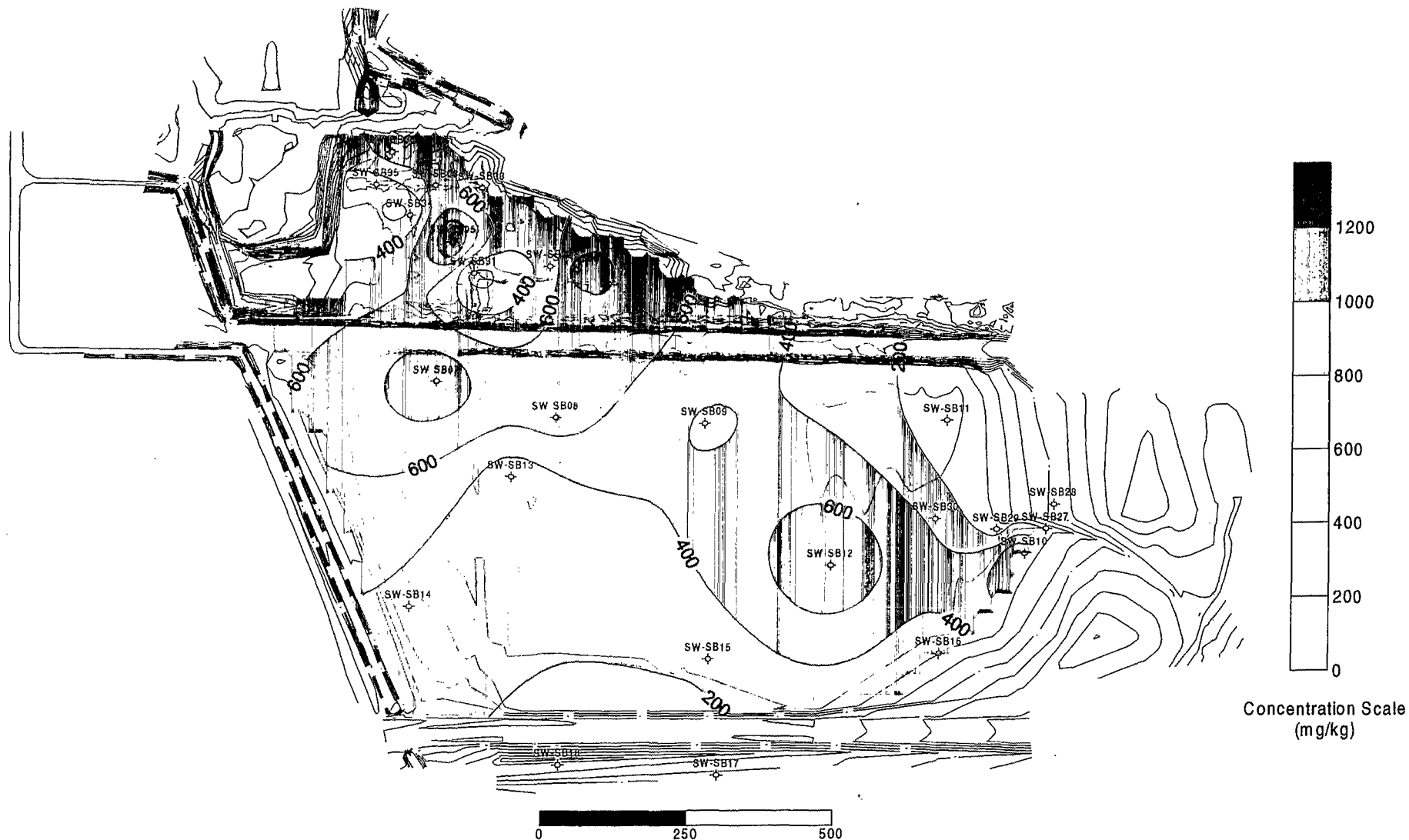


Figure 3-7
 VANADIUM DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

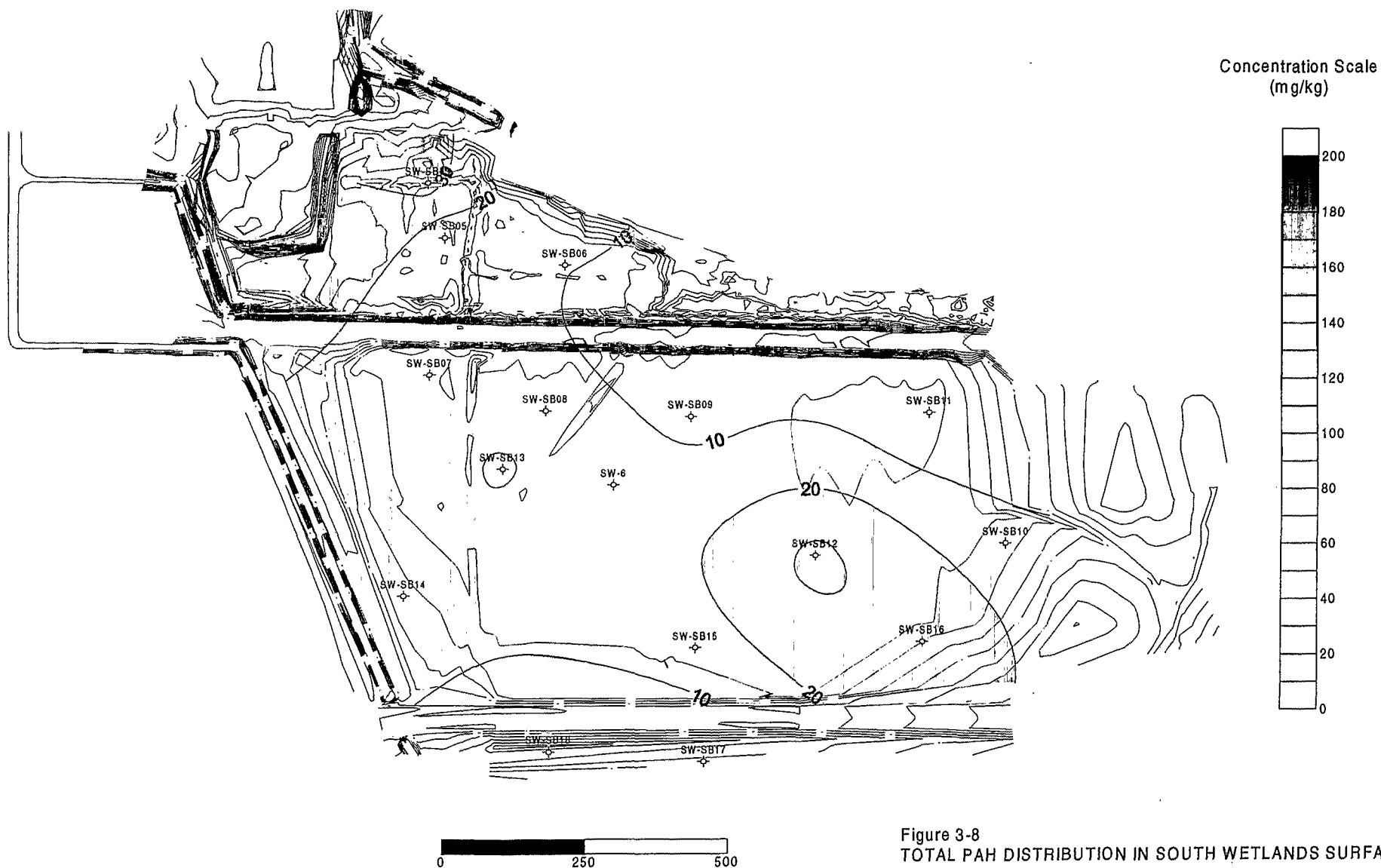


Figure 3-8
TOTAL PAH DISTRIBUTION IN SOUTH WETLANDS SURFACE SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial Investigation Report

SECTION 4

Wastewater Discharge Areas

SECTION 4

Wastewater Discharge Areas

This section presents a description of the wastewater discharge areas at the RMC site and data-gathering activities in these areas. The major wastewater discharge areas are Company Lake and South Ditch, shown in Figure 4-1. Two smaller areas, the outfall ditch and a depression east of the outfall ditch, receive discharge from Company Lake and are also shown in Figure 4-1.

4.1 South Ditch

This section contains a description of South Ditch and a summary of South Ditch investigation activities and results. Detailed information relating to South Ditch can be found in the documents below.

- *Final Site Inspection Prioritization Report* (PRC, October 19, 1993)
- *Technical Memorandum DS No. 3: East Potliner Area: Supplemental Data-Gathering Summary* (CH2M HILL, June 15, 1995)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Final Report: East Potliner Area Removal Action* (CH2M HILL, April 3, 1997)
- *Wastewater Discharge Areas Addendum to the RI/FS Work Plan* (CH2M HILL, December 1997)*
- *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997)
- *Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 2* (June 17, 1998)

4.1.1 Description of South Ditch

South Ditch is a manmade ditch that serves as the primary surface water drainage feature for the RMC facility. The upstream end of South Ditch begins just inside the COE dike, northeast of the plant. The ditch receives runoff and seepage from the area southwest of the dike and east of the plant (Figure 4-1). It flows south from the dike, turns west at the southeast corner of the scrap yard, and flows along the southern edge of the plant, terminating at a pump station near the southwestern corner of the reduction facility. The water in the South Ditch forebay at the pump station is pumped underground and discharged to Company Lake.

* Document was originally submitted EPA in March 1997. EPA approved the proposed investigation, but requested changes in language dealing with regulatory issues. The investigation was conducted in summer 1997 and the revised work plan and data summary were both submitted in December 1997.

South Ditch is part of the facility's NPDES-permitted industrial and stormwater discharge system and is regulated by the Oregon Department of Environmental Quality (DEQ). From the dike to a point south of the bakehouse, indicated in Figure 4-1, East South Ditch carries mainly surface water runoff and receives groundwater discharge during periods of seasonally high groundwater levels. In 1995, sediments were removed from the eastern end of South Ditch as part of the time-critical removal action at the east potliner area.

The eastern portion of South Ditch has existed since the early days of plant operation and is primarily used for stormwater conveyance. Before 1965, plant stormwater and wastewater discharges were directed through several channels to the south wetlands. The western half of the ditch was aligned in its current configuration (which includes remnants of the original channels) in approximately 1965.

West South Ditch receives water from the bakehouse dewatering sumps, stormwater from the plant, process cooling water, boiler blowdown, effluent from the RMC sewage treatment plant, effluent from the RMC process wastewater treatment plant, and groundwater discharge during periods of seasonally high groundwater levels. In early 1998, RMC dredged sediment from the pump forebay and a portion of West South Ditch.

Aerial photographs indicate that South Ditch at one time terminated at a forebay for a pump station that has since been covered by the north end of Potline 5. When construction began on Potline 5 in about 1969, the pump station was moved south to its current location.

Constituents in South Ditch are above background concentrations as a result of discharges from permitted process water, wastewater, stormwater, and shallow groundwater.

4.1.2 Summary of Investigations at South Ditch

A summary of the investigations conducted at South Ditch is provided in Table 4-1. This table includes a summary of samples collected, evaluations performed, key findings, and references to documentation and analytical results.

4.1.3 Nature and Extent of Chemical Constituents at South Ditch

Constituents in South Ditch above background concentrations are a result of discharges from permitted process water, wastewater, stormwater, and potentially shallow groundwater. Shallow groundwater from soil and debris areas near South Ditch (that is, east potliner, scrap yard, south landfill, and cryolite ponds) discharges seasonally into South Ditch.

In its eastern portion, South Ditch usually contains no standing or flowing water during the dry season. In its western portion, South Ditch typically contains standing or flowing water because of discharges from plant activities. Table 4-2 presents a summary of surface water and sediment samples collected from the eastern and western portions of South Ditch before and after the early action removal of East South Ditch sediments. This early action removal was part of the removal action conducted at east potliner in 1995.

4.1.3.1 East South Ditch

Surface Water. In East South Ditch, surface water samples were collected at five locations, and field fluoride samples were taken from fourteen locations in May 1997 (see Figure 4-2).

Constituents detected included fluoride, cyanide, and metals. Field fluoride values were found to be significantly higher adjacent to east potliner, indicating this area to be a possible fluoride source. Fluoride values decreased with distance from east potliner. Field fluoride values ranged from 37.8 mg/L near east potliner to a minimum downstream concentration of 3.55 mg/L. There were no measurable differences in concentrations between stations downstream, outside the influence of east potliner, to suggest any additional fluoride source areas.

Cyanide was detected at low concentrations (below 0.028 mg/L) with the exception of one higher sample (0.048 mg/L), and metals were detected at low concentrations. No polycyclic biphenyls (PCBs) or polynuclear aromatic hydrocarbons (PAHs) were detected in surface water samples. Analytical results of these surface water samples can be found in Table 4-3.

Sediment. One sediment sample was collected adjacent to east potliner after removal activities in 1996. The constituents detected in this sample are cyanide, fluoride, metals, and PAHs. Constituent levels were at lower concentrations than detected in West South Ditch. Sediment samples were collected from five locations in East South Ditch in 1997 (see Figure 4-2). Elevated levels of fluoride, total organic carbon (TOC), metals, and PAHs were detected at sample location SD-SD01, located approximately 25 feet upstream of the dividing line between East and West South Ditch. Elevated PAH concentrations were also detected at a location approximately 325 feet upstream of the dividing line between East and West South Ditch. No PCBs were detected in sediment samples. No obvious trends in constituent concentrations were observed that pointed to specific source areas. Analytical results of these sediment samples can be found in Table 4-4.

A search of PAH data from past investigations in potential source areas located adjacent to South Ditch (east potliner, scrap yard, and south landfill) did not identify a link to any of the source areas. The source of PAH concentrations at SD-SD01 and SD-SD02 may result from discharges from the inlet discovered in spring 1999, located just upstream (see Figure 4-2). Analysis of both of these samples required high dilutions, which increased the detection limit by a factor of 250. Because the detected values were less than five times the detection limit, there is some uncertainty about the precision and accuracy of these results.

4.1.3.2 West South Ditch

The constituents present in the West South Ditch sediments are cyanide, fluoride, metals, and PAHs. Tables 4-5 and 4-6 show sediment sample results for the 1993 investigation in West South Ditch. On the basis of the typical deposition patterns observed in channels, an accumulation of discharged solids would be expected to be highest in the downstream reach, nearest the forebay. However, because the forebay has been dredged more frequently than the rest of the ditch, the discharged solids and associated constituents have probably been removed from the forebay. This thesis is supported by the fact that the sediment at a station just upstream of the forebay had higher concentrations of constituents than the station located at the forebay. Concentrations of fluoride, metals, and PAHs in sediments typically decreased with distance from the forebay, except that higher PAH concentrations were detected near the bakehouse sump discharge to the South Ditch (located at the most upstream portion of West South Ditch).

The constituent types present in West South Ditch surface water were similar to those detected in sediments (cyanide, fluoride, metals, and PAHs). Table 4-7 shows surface water sample results from the 1993 investigation at West South Ditch. Surface water discharged from West South Ditch to Company Lake is regulated under the conditions of RMC's NPDES permit.

4.1.4 Fate and Transport Issues at South Ditch

In general, the potential for constituents in surface water and sediment in South Ditch to impact other surface water and groundwater appears to be low, as explained below.

4.1.4.1 Constituent Migration to Surface Water

South Ditch is part of the facility's NPDES-permitted industrial and stormwater discharge system and is regulated by DEQ. Constituents transported from South Ditch surface water or sediments via Company Lake to the Columbia River are monitored under the NPDES permit.

4.1.4.2 Constituent Migration to Groundwater

Groundwater elevations across the site, and along South Ditch, show a downward trend between the end of May and the end of September 1997, reflecting a seasonal decline in the water table as summer progresses.

East South Ditch, which does not receive wastewater discharges, is a gaining ditch during the winter months when groundwater elevations are at their seasonal high levels. It then becomes a losing ditch for a period of 2 to 4 weeks during the year. During this period the ditch provides recharge to groundwater until it goes dry. This seasonal pattern of the ditch drying up appears to be consistent from year to year. Because East South Ditch goes dry about the time groundwater levels drop, the constituent migration from East South Ditch to groundwater is expected to be minimal.

West South Ditch becomes a losing ditch around the end of June to mid-July, as groundwater levels drop below surface water levels in the ditch. Because this portion of the ditch receives stormwater, process water, and wastewater from several outfalls, the ditch does not go dry and continues to recharge groundwater throughout the summer and early fall. The estimated order-of-magnitude flux through the bottom and sides of West South Ditch during dry season conditions is approximately 10^{-4} ft³/sec (or approximately 129 gpd). Based on a potential range of hydraulic conductivity that could be present in the material along the ditch walls/bottom, the flux could range from 10^{-5} ft³/sec (or approximately 10 gpd) to 10^{-3} ft³/sec (1,300 gpd). Because leakage out of West South Ditch is small, the potential for surface water constituents to impact groundwater is low. The estimated loss of fluoride to groundwater during the period of maximum seepage is less than 1 lb/day (based on a concentration of 11 mg/L fluoride in the water at West South Ditch). During the transitional periods, when groundwater elevations are declining and vertical hydraulic gradients are less than maximum, fluoride loading is even less. (For further discussion, see Attachment A of *Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 2.*)

4.2 Company Lake

This section contains a description of Company Lake and a summary of Company Lake investigation activities and results. More information related to this area can be found in the documents referenced below.

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary* (CH2M HILL, March 26, 1997)
- *Wastewater Discharge Areas Addendum to the RI/FS Work Plan* (CH2M HILL, December 1997) (Originally submitted in March 1997; see explanation on page 4-1.)
- *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997)
- *Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 2* (CH2M HILL, June 17, 1998)

4.2.1 Description of Company Lake

Company Lake is used as a wastewater treatment pond. It is oriented east-west and is located north of the COE dike, directly north of the plant (see Figure 4-1). The treatment pond is estimated to be approximately 600,000 square feet or 14 acres in area with a normal surface water elevation of about 15.5 feet [National Geodetic Vertical Datum (NGVD)]. It is bordered on the north by native and non-native vegetation, including stands of hardwoods and Himalayan blackberries. The COE dike forms the southern border; the northern face of the dike has been partially lined with refractory brick that extends into the pond. An outfall ditch connects the northwest corner of Company Lake and the Columbia River. The western boundary of the pond and outfall ditch is Gresham Sand and Gravel (GS&G) property. The outfall road passes by the eastern end. A fence along the outfall road, from the top of the COE dike to north landfill, limits access to Company Lake.

West Company Lake was once part of Company Lake but was filled and is now owned by GS&G. Dredged materials from the river are stockpiled over West Company Lake as part of the GS&G operations. Borings through West Company Lake indicate that existing fill material is 8 to 24 feet deep.

RMC stormwater and wastewater from South Ditch enter the treatment pond from a discharge pipe at the southwestern end of the pond. The discharge pipe is oriented to discharge and distribute suspended solids toward the east.

The outfall ditch drains from the northwestern end of the treatment pond and flows north through a Parshall flume, where it discharges through an outfall pipe into the Columbia River. This discharge is permitted under RMC's NPDES discharge permit. RMC personnel routinely measure the flow rate and collect samples at the flume, as required for NPDES

permitting. During periods of high water in the Columbia River, water flows from the river into Company Lake via the outfall ditch.

A depression located on the eastern side of the outfall ditch, about midway between Company Lake and the Columbia River, has been observed to collect surface water when river levels are high (see Figure 4-3). The depression appears to be part of a former small channel that extended to the Sandy River. The depression, which is approximately 700 by 80 feet, is now isolated from surface runoff to the east by a road and to the west by the outfall ditch berm. The berm separating the outfall ditch from the depression is at an elevation of approximately 18 feet NGVD. Discharge water may enter the depression area when the Columbia River floods into the outfall ditch and causes the water elevation to rise above the level of the berm.

Both surface water and shallow groundwater north of the dike eventually discharge to the Columbia River.

From 1947 to approximately 1965, industrial wastewater and stormwater were discharged to south wetlands and pumped from south wetlands to Company Lake before discharge to the Columbia River. Company Lake was recognized as part of the treatment system in 1965, when the first NPDES permit was obtained. Since 1965, permitted NPDES wastewater and stormwater flows have been discharged to South Ditch and pumped from there into Company Lake.

Between 1975 and 1989 the bleed stream from the air emission control system on the carbon bake electrostatic precipitators (ESPs) discharged to South Ditch and Company Lake. This discharge was the primary source of the high-PAH process residue that has been deposited in Company Lake. Since 1989 the bleed stream has been treated by CaCl precipitation and clarification before being discharged to South Ditch. The process residue has a consistency of very wet elastic silt and typically exhibits a slight sheen. The underlying native sediment is visually distinct and is composed of silt or sandy silt. The process residue thickness varies from 0.1 to 2.5 feet; the thickest accumulations occur in the shallow western portion (near the existing inlet pipe from South Ditch) and in the deeper eastern portion.

4.2.2 Summary of Investigations at Company Lake

A summary of the investigations conducted at Company Lake is provided in Table 4-8. This table includes a summary of samples collected, evaluations performed, key findings, and references to documentation and analytical results.

4.2.3 Nature and Extent of Chemical Constituents at Company Lake

4.2.3.1 Constituent Distribution

Constituent distribution for Company Lake, West Company Lake, and the depression east of the outfall ditch is described below. *Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary* provides a more detailed description.

Company Lake. The primary source of constituents at Company Lake is believed to be historical wastewater discharges, largely from an air emission control system bleed stream which has been discontinued. The pond is a part of the RMC treatment system, as

recognized by its NPDES permit, and predominantly serves to equalize and attenuate peak discharges of dissolved permitted constituents before discharging to the Columbia River.

Sediment. Constituents detected in the process residue are consistent with those in the permitted waste streams. Table 4-9 compares constituent concentrations in process residue with concentrations in native sediments. Samples were collected during the 1996 investigation. The process residue contained elevated concentrations of fluoride, metals, PAHs, and total petroleum hydrocarbon (TPH). Relatively low concentrations of cyanide and PCBs were detected in some process residue samples. No volatile organic compounds (VOCs) were detected in any samples.

Concentrations of constituents detected in the underlying native sediment suggest that the native sediment is relatively unaffected by constituents in the process residue or process wastewater, except for fluoride as measured by EPA Method 300.0 (which is believed to present soluble fluoride). No cyanide, PCBs, TPH, or VOCs were detected, and low concentrations of PAHs were detected in native sediment. Metal concentrations in native sediment are similar to background concentrations (*Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary*).

Surface Water. On the basis of the surface water samples collected by CH2M HILL and as part of the routine NPDES monitoring performed by RMC, it does not appear that high concentrations of constituents are normally discharging via the outfall ditch to the Columbia River. Discharge to the Columbia River of pH, oil and grease, total suspended solids (TSS), cyanide, fluoride, aluminum, antimony, nickel, and benzo(a)pyrene is regulated under the NPDES permit. The discharge is monitored regularly and monthly reports are submitted to DEQ.

Shoreline Brick. The brick located along the COE dike appears to be an insignificant source to Company Lake sediment and surface water, or to groundwater. Additional discussion of the brick is provided in *Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary*. Soil samples collected from within and under the brick suggest that it may contribute low levels of fluoride, metals, and PAHs to interstitial soil, but these concentrations are significantly lower than those found in Company Lake sediment. Direct contact exposure with interstitial soil is unlikely because it is covered with brick. Tests conducted in "dirty" brick directly from the bakehouse are consistent with concentrations in brick soil, indicating that the brick has not been a major contributor of constituents to Company Lake sediment or groundwater (*Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary*).

West Company Lake. Borings in West Company Lake indicate that the existing fill material is 8 to 24 feet deep. Below this fill, a potential layer of process residue (6 to 12 inches thick) was noted in several borings, although the layer did not appear to be composed entirely of process residue, as was observed in Company Lake. Deposition of process residue in West Company Lake occurred from 1947 to 1970. Constituents in the process residue layer are fluoride, metals, and PAHs, but at concentrations lower than detected in Company Lake sediment. This is consistent with the belief that the primary source of PAHs in Company Lake is the bleed stream from the carbon bake air emissions control system, which was discharged from 1975 to 1989. The process residue in West Company Lake was either

unevenly distributed or was disturbed during fill activities by GS&G. Direct contact exposure is unlikely because of the amount of fill over the process residue layer.

Depression East of Outfall Ditch. Solids suspended in the wastewater that overflows into the depression east of the outfall ditch would be expected to settle near the outfall ditch.

One soil sample collected in 1996 approximately 100 feet east of the outfall ditch contained low-level concentrations of fluoride, metals, and PAHs. In September 1997, five surface soil samples were collected along an east-west transect in the depression and were composited into one sample (see Figure 4-3). Samples were analyzed for cyanide, fluoride, TOC, metals, PAHs, and PCBs. Table 4-10 shows sample results compared to background concentrations. Concentrations of the composite sample are consistent with concentrations found in the discrete sample taken in October 1996. PCBs and cyanide were not detected. Fluoride was detected at 400 mg/kg. Eleven species of PAHs were detected at low levels (<0.5 mg/kg).

4.2.4 Fate and Transport Issues at Company Lake

The constituents contained in Company Lake surface water and sediment can potentially be transported to the Columbia River via the NPDES-permitted outfall. Dissolved constituents can potentially also migrate to groundwater below the pond.

4.2.4.1 Constituent Migration to the Columbia River

RMC uses Company Lake as part of its permitted NPDES wastewater treatment system. Any constituents that migrate from RMC wastewater, stormwater, or Company Lake surface water and sediment are subject to the requirements of RMC's NPDES permit. The NPDES outfall is regularly monitored and sampled under the conditions specified by the permit.

4.2.4.2 Constituent Migration to Groundwater

More detailed descriptions of the groundwater/surface water interactions at Company Lake are presented in *Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan: Part 2* and in Section 3 of the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999).

Depending on the season and on river stage fluctuations, the elevation of the surface water at Company Lake can be above or below the groundwater. A water balance was performed for the pond during a period when groundwater was consistently below the pond levels in fall 1997. The results suggested that groundwater was being recharged by the pond at a rate of between approximately 280,000 and 430,000 gallons per day (gpd). It is likely that this flow occurred through both the bed of the pond and the sidewalls, which consist of both native and non-native materials.

Groundwater quality data also suggest that leachate from the pond has affected groundwater in the area. The highest fluoride concentrations measured in Geoprobe downgradient of the pond during 1997 ranged from 15.9 to 24.5 mg/L, which is comparable to concentrations of 18.2 to 23.2 mg/L that were measured in leachate tests on pond sediment in 1997. Geochemical analyses (Piper trilinear diagrams) of groundwater, pond water, and leachate from core samples of the pond bed also suggest that the pond has altered the

geochemistry of the groundwater and has been a long-term source of water to the underlying groundwater system.

Fluoride loading from Company Lake to groundwater was estimated at approximately 10 lb/day through vertical leakage and about 7.5 lb/day via horizontal leakage. These estimates are conservative (high) because they are based on conditions when maximum hydraulic gradients occur.

Tables

Table 4-1
Summary of Investigations at South Ditch

Investigation	Description	Key Findings	References
EPA Site Inspection (1993)	Surface water samples from seven locations and sediment samples from five locations in West South Ditch (from the bakehouse sumps to the forebay).	Detected cyanide, fluoride, metals, PAHs, and one VOC (toluene) in sediments; lowest concentrations were detected in the eastern end of West South Ditch with increasing concentrations downstream; higher PAHs were detected near the bakehouse sump discharge. Detected cyanide, fluoride, metals, and PAHs in surface water samples. PCBs were not detected in sediments or surface water.	<i>Final Site Inspection Prioritization Report</i> (PRC, October 19, 1993)
East Potliner Area Investigation (1995)	Surface water and sediment samples from two locations in East South Ditch, within east potliner area. Samples collected before implementation of early actions.	Detected cyanide, fluoride, and PAHs in sediment at generally lower concentrations than West South Ditch. Detected cyanide and fluoride in surface water at similar concentrations to West South Ditch. PAHs were not detected in surface water.	<i>Technical Memorandum DS No. 3: East Potliner Area: Supplemental Data-Gathering Summary</i> (CH2M HILL, June 15, 1995)
Bakehouse Sump Investigation (1995)	Sediment sample from one location in South Ditch, adjacent to the discharge point of the bakehouse sump outfall pipe.	Detected cyanide, fluoride, metals, and PAHs at concentrations similar to EPA site inspection sample located close to bakehouse sump outfall. PCBs were undetected.	<i>Draft Current Situation Summary</i> (CH2M HILL, April 5, 1996)
East Potliner Area Confirmation Sampling (1996)	Sediment sample from one location in East South Ditch, within east potliner area. Sample collected after implementation of early actions.	Detected cyanide, fluoride, and metals at generally lower concentrations than West South Ditch.	<i>Final Report: East Potliner Area Removal Action</i> (CH2M HILL, April 3, 1997)
East South Ditch Investigation (1997)	Surface water samples from five locations in East South Ditch, and field fluoride measurements taken at 14 locations along the extent of East South Ditch.	Detected fluoride, cyanide, and metals in surface water samples; fluoride concentrations were higher near east potliner; cyanide was detected at low concentrations except higher in one sample; metals were detected at low concentrations. No PCBs or PAHs were detected in surface water samples.	<i>Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1</i> (CH2M HILL, December 12, 1997)
	Sediment samples from five locations in East South Ditch.	Detected fluoride and metals at one location. Elevated PAH concentrations were detected at one location. No obvious trends in constituent concentrations pointing to specific source areas. No PCBs detected in sediment samples.	<i>Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1</i> (CH2M HILL, December 12, 1997)

Table 4-1
Summary of Investigations at South Ditch

Investigation	Description	Key Findings	References
	Collected weekly surface water and groundwater elevation data from May through September 1997 at eight staff gauges, 26 monitoring wells, the South Ditch pump station, and 16 temporary piezometers to monitor groundwater and surface water interactions at South Ditch.	<p>East South Ditch loses water to groundwater for a very brief period during dry summer months until it goes dry.</p> <p>West South Ditch loses water to groundwater in the drier summer months when groundwater levels drop below surface water levels in the ditch. West South Ditch continues to discharge to groundwater throughout the summer and early fall months, but the leakage rate and loss of constituents to groundwater is believed to be small.</p>	<i>Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 2: Attachment A (CH2M HILL, June 17, 1998)</i>

Table 4-2
Summary of South Ditch Surface Water and Sediment Data

	Surface Water (mg/L)			Sediment (mg/kg)		
	West South Ditch	East South Ditch		West South Ditch	East South Ditch	
		1995	1997		1995	1997
Cyanide	ND - 0.069	0.023 - 0.083	ND - .048	ND - 10	ND - 3.3	ND - 11.0
Fluoride	6.4 - 18.9	4.4 - 6.9	3.55 - 37.8	731 - 127,000	510 - 1200	26 - 17,6002
Aluminum	0.49 - 1.97	NA	0.259 - 1.13	6,360 - 121,000	NA	3,420 - 37,200
Total PAHs	0.017-0.5	ND	ND	212 - 9,964	ND - 237	2.2 - 3389
Total PCBs	ND	NA	ND	ND	NA	ND

NA = not analyzed.

ND = not detected.

Includes results of EPA Method 300.0 and Field Fluoride.

Includes results of EPA Methods 300.0 and 340.1/340.2.

Total PAH values were calculated by adding the values of each PAH species. Nondetects were given no value.

Sources: *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS, Part 1* (CH2M HILL, December 12, 1997) and *Wastewater Discharge Areas Addendum to the RI/FS Work Plan* (December 1997).

**Table 4-3
East South Ditch Surface Water Results (1997)**

Sample ID	SD-SW01-12997-0	SD-SW02-12997-0	SD-SW03-12997-0	SD-SW04-12997-0	SD-SW05-12997-0	Salmon Creek Background Data*	
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	Minimum	Maximum
Analyte (mg/L)							
Cyanide, Total	0.027	0.047	0.028	0.02 U	0.048	0.01 U	0.02 U
Fluoride By 300.0	5.31	5.12	4.51	4.98	25.4	0.25 U	0.5 U
Dissolved Metals							
Aluminum	0.839	0.376	0.259	0.402	1.13		
Antimony	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U		
Arsenic	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U		
Barium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U		
Beryllium	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U		
Cadmium	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U		
Calcium	5.88	7.79	8.67	8.27	4.75		
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Cobalt	0.005 U	0.005 U	0.0087	0.005 U	0.005 U		
Copper	0.0042 U	0.0037 U	0.0034 U	0.0035 U	0.0094 U		
Iron	0.581	0.954	1.52	1.99	0.81		
Lead	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		
Magnesium	1.57	2.1	2.25	2.33	1.37		
Manganese	0.114	0.563	2.8	0.623	0.105		
Mercury	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U		
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U		
Potassium	2.76	2.73	3.32	2.7	2.84		
Sodium	10	10.6	11.8	12.6	52.6		
Vanadium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U		
Zinc	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U		
Total Metals							
Aluminum	0.96	0.613	0.359	0.51	1.46	0.1	0.14
Antimony	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.01 U	0.01 U
Arsenic	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Barium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Beryllium	0.00044	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.02 U
Cadmium	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0003 U	0.002 U
Calcium	5.94	7.86	8.72	8.17	4.79	13	15.3
Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.02 U
Cobalt	0.005 U	0.005 U	0.008	0.005 U	0.005 U	0.05 U	0.05 U
Copper	0.0067 U	0.0114 U	0.0049 U	0.0052 U	0.0101 U	0.002 U	0.02 U
Iron	1.4	2.29	5	5.91	1.21	0.169	0.63
Lead	0.001 U	0.0017	0.001 U	0.001 U	0.001 U	0.001 U	0.004 U
Magnesium	1.62	2.13	2.27	2.32	1.36	5.6	6.2
Manganese	0.151	0.594	2.75	0.563	0.103	0.027	0.058
Mercury	0.0002 U	0.0002 U	0.0002 U	0.00022	0.0002 U	0.0002 U	0.001 U
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.05 U
Potassium	2.84	2.87	3.39	3.08	2.98	2.3	3.1
Sodium	9.98	10.8	12.1	12.6	53.5	5.8	7.6
Vanadium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Zinc	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PAHs							
2-Methylnaphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Acenaphthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Acenaphthylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Benzo(a)Anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Benzo(a)Pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Benzo(b)Fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Benzo(g,h,i)Perylene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Benzo(k)Fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Chrysene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Dibenzo(a,h)Anthracene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Fluoranthene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Fluorene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Indeno(1,2,3-cd)Pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Naphthalene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Phenanthrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		
Pyrene	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		

**Table 4-3
East South Ditch Surface Water Results (1997)**

Sample ID	SD-SW01-12997-0	SD-SW02-12997-0	SD-SW03-12997-0	SD-SW04-12997-0	SD-SW05-12997-0	Salmon Creek Background Data*	
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97		
Analyte (mg/L)						Minimum	Maximum
PCBs							
Aroclor 1016	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1221	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U[J]		
Aroclor 1232	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1242	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1248	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1254	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1260	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1262	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		
Aroclor 1268	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U[J]		

* = Based on three surface water samples (Technical Memorandum DS No. 12: Background Data Summary for RMC-Troutdale, CH2M HILL, December 3, 1996).

J = estimated value.

U = undetected.

() = Advisory flag based on professional judgment rather than method protocol.

Source: Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS, Part 1 (CH2M HILL, December 12, 1997).

Table 4-4
East South Ditch Sediment Results (1997)

Sample ID	SD-SD01-13697-0	SD-SD02-0000-0	SD-SD03-0000-0	SD-SD04-0000-0	SD-SD05-0000-0
Sample Date	5/16/97	5/9/97	5/9/97	5/9/97	5/9/97
Analyte (mg/kg)					
Cyanide, Total	0.74 U	9.15	3.69	11	2.07
Fluoride, GI extraction	75 U	4110 [J]	75 U[J]	75 U[J]	75 U[J]
Fluoride, with Distillation	181	17600	167	394	177
Fluoride By 340.1/2	520 J	8500 J	220 J	380 J	270 J
Fluoride By 300.0	46 D[J]	660 D[J]	26 D[J]	48 D[J]	100 D[J]
Total Organic Carbon	27200	130000	18100	66000	3220
Total Metals					
Aluminum	3420	37200	4120	9950	3910
Antimony	3.7 U	7.9 U	4 U	5.9 U	3.4 U
Arsenic	0.95	15.5	2.2	2.5	0.68
Barium	13.7	148	20.3	65.1	13.7
Beryllium	0.74 U	2.5	0.79 U	1.2 U	0.68 U
Cadmium	0.74 U	6	0.79 U	1.2 U	0.68 U
Calcium	2270	12900	1840	3090	2030
Chromium	5.1	91.4	5.1	10.2	4.9
Cobalt	3.7 U	20.2	4 U	5.9 U	3.4 U
Copper	37.2	832	21	42.2	9.1
Iron	4770	31000	5000	10600	5010
Lead	7.4 U	165	7.9 U	13	6.8 U
Magnesium	522	3980	521	1490	518
Manganese	30.1	430 [J]	74.4 [J]	116 [J]	57.9 [J]
Mercury	0.08 U	3.1	0.09 U	0.13 U	0.08 U
Nickel	4.5	225	3.8	12.2	3.1
Potassium	238	950	237	573	168
Sodium	550	2320	460	745	796
Vanadium	20.7	144	20.6	39.2	17.7
Zinc	20.4	290 [J]	22.4 [J]	55.2 [J]	14 [J]
PAHs					
2-Methylnaphthalene	120 U	100 U	0.52 U	0.79 U	0.45 U
Acenaphthene	120 U	23 J	0.52 U	0.08 J	0.45 U
Acenaphthylene	120 U	100 U	0.52 U	0.79 U	0.45 U
Anthracene	7.4 J	30 J	0.52 U	0.1 J	0.45 U
Benzo(a)Anthracene	320	330	0.29 J	0.96 [J]	0.2 J
Benzo(a)Pyrene	300	420 [J]	0.61 [J]	1.3 [J]	0.28 J
Benzo(b)Fluoranthene	570	370 [J]	0.42 J	1.5 [J]	0.27 J
Benzo(g,h,i)Perylene	200	190 [J]	2.8 [J]	0.57 J	0.14 J
Benzo(k)Fluoranthene	350	280 [J]	0.29 J	0.9 [J]	0.19 J
Chrysene	570	390	0.36 J	1.2 [J]	0.26 J
Dibenzo(a,h)Anthracene	72 J	96 J	0.088 J	0.35 J	0.065 J
Fluoranthene	260	480	0.38 J	1.5 [J]	0.35 J
Fluorene	120 U	100 U	0.52 U	0.79 U	0.45 U
Indeno(1,2,3-cd)Pyrene	190	230 [J]	0.32 J	0.77 J	0.16 J
Naphthalene	120 U	100 U	0.52 U	0.79 U	0.45 U
Phenanthrene	9.9 J	140	0.14 J	0.54 J	0.12 J
Pyrene	540	300	0.41 J	1.2 [J]	0.2 J
Total PAHs	3389	3279	6.1	11	2.2
PCBs					
Aroclor 1016	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1221	0.99 UR	2.1 U[J]	0.21 U	0.32 U	0.18 U
Aroclor 1232	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1242	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1248	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1254	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1260	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1262	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U
Aroclor 1268	0.49 UR	1 U[J]	0.1 U	0.16 U	0.09 U

D = Compound has been run at a dilution to bring the concentration of that compound within the linear range of the instrument.

J = estimated value.

R = Result is rejected due to gross QA/QC outliers; presence or absence of material cannot be certain.

U = undetected.

[] = Advisory flag based on professional judgment rather than method protocol.

GI Extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be bioavailable.

Source: Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS, Part 1

(CH2M HILL, December 12, 1997).

Table 4-5

West South Ditch Sediment Analytical Results: Inorganic Compounds and Metals (1993)

Constituent	SD-07	SD-08	SD-09	SD-13	SD-14
Inorganic Compounds (mg/kg)					
Cyanide	9.1	12.5 U	4.1	10	5.5 U
Fluoride	8,160	127,000	6,630	4,750	731
Metals (mg/kg)					
Aluminum	117,000 J	121,000 J	34,400 J	14,200 J	6,360 J
Arsenic	9.3 U	64.8	30.1	2.2 U	4.1
Barium	276	253	45.6	21.1	36.1
Beryllium	4.4	3.5	1.1	0.74	0.76 U
Cadmium	4.8 U	16.9	1.9 U	0.72 U	10.4
Calcium	13,600 J	126,000 J	3,150 J	4,230 J	2,880 J
Chromium	53.1	31.7	24	10.2	9.6
Cobalt	13.2	15.7	5.6	4.6	4.4 U
Copper	409 J	616 J	626 J	52.4 J	180 J
Iron	24,900 J	21,900 J	10,000 J	7,330 J	5,710 J
Lead	29.2 J	54.1 J	111 J	12.4 J	55.5 J
Magnesium	2,550 J	3,590 J	1,180 J	1,120 J	741 J
Manganese	2,660 J	481 J	137 J	65.2 J	47.3 J
Mercury	0.25 J	0.4 J	0.38 J	12 UJ	0.16 UJ
Nickel	298	542	67.8	34.3	17.7
Potassium	165 U	267 U	80.9 U	95.9 U	113 U
Selenium	9.5 R	16.3 R	4.8 R	0.51 R	0.62 R
Silver	1.2	2.5	0.48 U	0.57 U	0.68 U
Sodium	1,320	3,370	944	1,350	666
Thallium	0.48 U	1 J	0.24 UJ	0.25 UJ	0.35
Vanadium	113 J	136 J	32.6 J	41.9 J	26.2 J
Zinc	510 J	668 J	180 J	29.9 J	91.1 J

Notes:

U = The analyte was analyzed for, but was not detected above, the sample quantification limit (organic compounds) or detection limit (inorganic analytes). The associated numerical value indicates the approximate concentration necessary to detect the analyte in this sample.

J = The analyte was analyzed for and positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should seriously be considered for decision-making, and are usable for many purposes.

UJ = The analyte was analyzed for, but was not detected above, the sample quantification limit (organic compounds) or detection limit (inorganic analytes). However, the reported quantification (or detection) limit is approximate and may or may not represent the actual limit of quantification necessary to accurately and precisely measure the analyte in this sample.

R = The sample results were rejected because of serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.

Source: *Final Site Inspection Prioritization Report*, Table 4-3 (PRC, October 19, 1993).

Table 4-6
West South Ditch Sediment Analytical Results: Organic Compounds (1993)

Constituent	SD-07	SD-08	SD-09	SD-13	SD-14
PAHs (mg/kg)					
Acenaphthene	22 U	14 J	58	0.94 J	33
Acenaphthylene	22 U	36 U	14 U	17 U	0.8 J
Anthracene	22 U	77	82 J, D	2.5 J	55
Benzo(a)anthracene	37	1100 D	760 D	18	930 D
Benzo(a)pyrene	31	540 D	560 D	17	740
Benzo(b)fluoranthene	77	1400 D	890 D	48	1200 D
Benzo(g,h,i)perylene	23	420 D	510 D	18	460
Benzo(k)fluoranthene	22 U	36 U	14 U	17 U	14 U
Chrysene	44	1900 D	750 D	29	1200 D
Di-n-butylphthalate	22 U	36 U	14 U	0.95 J	1 J
Dibenz(a,h)anthracene	63 J	120	240 J, D	6.9 J	190
Dibenzofuran	22 U	5.2 J	6.5 J	17 U	6.2 J
Fluoranthene	55	1600 D	840 D	22	1200 D
Fluorene	22 U	24 J	15	17 U	30
Indeno(1,2,3-cd)pyrene	22	330 J, D	480 D	15 J	580
Naphthalene	22 U	1.5 J	1.9 J	17 U	1.7 J
Phenanthrene	22 U	350 J, D	270 D	7.8 J	300 D
Pyrene	56	2000 D	950 D	26	1600 D
SVOCs (mg/kg)					
2-methylnaphthalene	22 U	36 U	1.7 J	17 U	1.3 J
bis(2-ethylhexyl)phthalate	6 J	22 J	6.8 J	17 U	14 U
Carbazole	22 U	60	54	17 U	37
VOCs (mg/kg)					
1,1,2,2-tetrachloroethane	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
2-butanone	0.022 U	0.033 J1	0.01 J	0.017 U	14 U
2-hexanone	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
4-methyl-2-pentanone	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Acetone	0.04 U	0.87 J1	0.023 U	0.013 U	10 U
Chlorobenzene	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Ethylbenzene	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Styrene	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Tetrachloroethene	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Toluene	0.17	0.046	0.026	0.017 U	14 U
Xylene (total)	0.022 U, J4	0.036 U	0.014 U	0.017 U	14 U
Pesticides (mg/kg)					
4,4'-DDE	0.0052 R	0.00025 R	0.00081 R	0.0025 J	0.00039 R

Notes:

D = Sample was diluted because of high concentrations.

U = The analyte was analyzed for but not detected above sample quantification limit (organic compounds) or detection limit (inorganic analytes). The associated numerical value indicates the approximate concentration necessary to detect the analyte in this sample.

J = The analyte was analyzed for and positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be seriously considered for decision-making, and are usable for many purposes.

A suffix may be appended to the J qualifier, which identifies quality control (QC) criteria that were not met:

J1 = Laboratory blank contamination; possible high bias and/or false positives.

J4 = Other QC outside control limits; bias not readily determined

R = The sample results were rejected because of serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence of the analyte cannot be verified.

Source: PRC, 1993 (Table 4-3).

Table 4-7
West South Ditch Surface Water Analytical Results (1993)

Constituent	SW-01	SW-02	SW-03	SW-04	SW-05	SW-06
Inorg. Compounds (mg/L)						
Cyanide	0.01 U	0.01 U	0.01 U	0.0398	0.069	0.021
Fluoride (mg/L)	0.0064	0.0066	0.0086	0.0178	0.0189	0.0098
Metals (mg/L)						
Aluminum	0.628	0.492	0.574	1.56	1.97	1.14
Arsenic	0.0011	0.0011 U	0.0011 UJ	0.0011 UJ	0.0011	0.0011 UJ
Barium	0.0185	0.0128	0.0124	0.0143	0.0124	0.0129
Calcium	22.4	22.0	23.9	16.3	12.0	11.7
Copper	0.0126	0.0098 U	0.0094 U	0.0153	0.0185	0.015
Iron	1.1 J	1.07 J	0.528 J	0.491 J	0.418 J	0.292 J
Magnesium	5.46	5.29	5.46	4.2	4.07	4.0
Manganese	0.22	0.21	0.131	0.105	0.051	0.0385
Potassium	3.76	3.32 U	3.81	4.55	4.4 U	4.37 U
Sodium	32.5	31.9	39.7	69.9	68	47
PAHs (mg/L)						
Benzo(a)anthracene	0.0008 J	0.002 J	0.0008 J	0.01 U	0.01 U	0.01 U
Benzo(a)pyrene	0.001 J	0.002 J	0.001 J	0.01 U	0.01 U	0.01 U
Benzo(b)fluoranthene	0.002 J	0.004 J	0.002 J	0.01 U	0.0005 J	0.0006 J
Chrysene	0.002 J	0.002 J	0.002 J	0.01 U	0.01 U	0.01 U
Fluoranthene	0.002 J	0.004 J	0.0008 J	0.01 U	0.01 U	0.01 U
Pyrene	0.002 J	0.003 J	0.0007 J	0.01 U	0.01 U	0.01 U
SVOCs (mg/L)						
gamma-BHC (Lindane)	0.00005 U	0.00005 U	0.000014 J	0.00005 U	0.00005 U	0.00005 U
Di-n-butylphthalate	0.01 U	0.01 U	0.0006 J1	0.0006 J1	0.01 U	0.0007 J1
VOCs (mg/L)						
Acetone	0.01 U	0.01 U	0.008	0.008	0.008	0.01 U

Notes:

U = The analyte was analyzed for but not detected above sample quantification limit (organic compounds) or detection limit (inorganic analytes). The associated numerical value indicates the approximate concentration necessary to detect the analyte in this sample.

J = The analyte was analyzed for and positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be seriously considered for decision-making, and are usable for many purposes.

A suffix may be appended to the J qualifier, which identifies quality control (QC) criteria that were not met:

J1 = Laboratory blank contamination; possible high bias and/or false positives.

Source: *Final Site Inspection Prioritization Report*, Table 4-6 (PRC, October 19, 1993).

Table 4-8
Summary of Investigations at Company Lake

Investigation	Description	Key Findings	Reference
Removal Site Assessment (1994)	Sediment samples collected from five locations in the pond and one location in the outfall ditch. Surface water samples collected from two locations in the pond and one in the outfall ditch. Soil samples collected at two locations within the brick matrix along the south face of dike.	Detected cyanide, fluoride, metals, PAHs, PCBs, and TPH in sediments; fluoride in surface water; low concentrations of PAHs in brick soils under brick.	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
Company Lake Supplemental Investigation (1996)	Surface and subsurface sediment samples collected at 16 locations in the pond and outfall ditch. Surface soil samples collected at two locations: in a depression east of the outfall ditch, and within the brick matrix along the south dike. Subsurface soil samples collected at three locations in West Company Lake.	Detected cyanide, fluoride, metals, PAHs, PCBs, and TPH in sediments. Detected low concentrations of fluoride, metals, and PAHs in soil under brick, depression soil, and subsurface soil of West Company Lake.	<i>Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary</i> (CH2M HILL, March 26, 1997)
	Company Lake bathymetric survey and topographic mapping.	The western portion of the pond has a gently sloping bottom, and the deeper eastern portion has steeper bottom slopes.	
	Vegetation Survey.	There are densely rooted aquatic plants in shallow areas of the pond. The dominant species are waterweed, curly-leaved pondweed, and eelgrass pondweed.	
	Evaluation of Potential Flood Impacts on the Company Lake Area.	Results of an evaluation of flood velocities in the Company Lake area indicate that the outfall road forms a barrier during low flood periods up to an elevation of 23.65 feet above mean sea level. Flood velocities tend to be reduced because of the topography and vegetation surrounding Company Lake, and are predicted to be less than 1 foot per second (ft/sec), even during a 500-year event.	

Table 4-8
Summary of Investigations at Company Lake

Investigation	Description	Key Findings	Reference
Data Collection for <i>Wastewater Discharge Areas Addendum to the RI/FS Work Plan</i> (1997)	Five surface soil samples were collected along an east-west transect in the depression east of the outfall ditch and composited into one sample. Samples were analyzed for cyanide, fluoride, TOC, metals, PAHs, and PCBs.	Fluoride was detected at 400 mg/kg, 11 species of PAHs were detected at low levels, and no cyanide or PCBs were detected.	<i>Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1</i> (CH2M HILL, December 12, 1997)
	Three sediment cores and 40 gallons of Company Lake surface water collected from Company Lake; sediment permeability and leachability tests conducted.	The range of permeability values for the native sediment cores was from 1 to 4 $\times 10^{-6}$ centimeters per second (cm/sec) when corrected from 4 to 20°C. The native sediment plus process residue cores yielded nearly identical permeability values of 3 to 5 $\times 10^{-6}$ cm/sec when corrected from 4° to 20°C.	
	Company Lake sediment/process residue settleability tests conducted.	The results from the settleability testing indicate that the process residue settles fairly rapidly. Discrete settling prevails in the upper zones, and hindered settling prevails in the lower zones. On the basis of these results, it is anticipated that process residue carryover to the outfall ditch can be controlled by conventional means during a removal action and that mechanical dewatering of the process residue would be effective.	
	A solubilization test was performed to determine whether constituents absorbed to the process residue or contained in pore water would solubilize during intensive agitation. These data are being used due to the likelihood of an NPDES exceedance during a removal action.	A possible NPDES exceedance for suspended solids, benzo(a)pyrene, nickel, and aluminum could occur during a removal action that produced intense mixing of sediments and process residue.	

Table 4-8
Summary of Investigations at Company Lake

Investigation	Description	Key Findings	Reference
	Company Lake inlet and outlet water quality monitoring.	Cyanide was not detected in any of the samples. Fluoride concentrations were consistently higher in the outlet than the inlet. Total and dissolved metal concentrations were generally higher in the inlet sample on September 18 and October 16, 1997; however, this was not the case on the other two sample dates. PAHs were detected at low levels in all the samples collected. Temperature at the inlet location was generally 10 to 15 degrees higher than at the outlet.	<i>Technical Memorandum DS No. 18: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 2</i> (CH2M HILL, June 17, 1998)
	Groundwater quality monitoring, water balance, Geoprobe investigation, and groundwater/surface water interaction evaluation conducted to determine impact of Company Lake surface water, sediments, and process residues on groundwater.	These evaluations were conducted to determine the interaction between Company Lake surface water and sediments and the underlying groundwater. The results of these evaluations are presented in the document referenced in this table, as well as in the <i>Draft Groundwater Remedial Investigation Report</i> (CH2M HILL, June 1999)	

Table 4-9
Comparison of 1996 Process Residue and Native Sediment Data for Company Lake

Analyte (mg/kg)*	Process Residue				Native Sediment			
	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect
Cyanide, Total	15	9	1.3	7.9	14	0		
Fluoride by 340.1/.2	15	15	7000	57000	14	14	300	3300
Fluoride By 300.0	15	15	3.5	170	14	14	14	89
Total Organic Carbon	15	15	20100	185000	14	14	2060	16400
Total Metals								
Aluminum	15	15	16100	74200	14	14	8190	24000
Antimony	15	1		3.6	14	0		
Arsenic	15	15	5.03	16.5	14	14	2.2	10.1
Barium	15	15	87.1	267	14	14	40.4	171
Beryllium	15	15	0.85	3.39	14	2	0.6	0.62
Cadmium	15	14	0.76	8.44	14	2	0.63	0.76
Calcium	15	15	10100	70500	14	14	3890	7030
Chromium	15	15	20.8	123	14	14	12.2	28
Cobalt	15	15	6.82	32.2	14	14	5.58	11.6
Copper	15	15	43.3	288	14	14	14.8	43.3
Iron	15	15	9500	26500	14	14	12900	29800
Lead	15	15	23.8	114	14	11	5.6	36.9
Magnesium	15	15	1700	5920	14	14	1650	5920
Manganese	15	15	155	2220	14	14	103	415
Mercury	15	15	0.23	1.07	14	0		
Nickel	15	15	42.5	790	14	14	9.93	38.4
Potassium	15	15	715	3350	14	14	476	2050
Selenium	15	14	1.3	6.7	14	0		
Silver	15	1		1.1	14	0		
Sodium	15	15	1260	6800	14	14	483	967
Thallium	15	1		1.3	14	0		
Vanadium	15	15	62.2	271	14	14	43.6	64.4
Zinc	15	15	73.9	1010	14	14	28.9	138
PAHs								
2-Methylnaphthalene	15	0			14	0		
Acenaphthene	15	2	0.17	0.98	14	1		0.092
Acenaphthylene	15	0			14	0		
Anthracene	15	15	0.064	26	14	0		
Benzo(a)anthracene	15	15	0.56	220	14	4	0.06	0.2
Benzo(a)pyrene	15	15	0.055	180	14	3	0.056	0.2
Benzo(b)fluoranthene	15	15	0.38	370	14	5	0.045	0.26
Benzo(g,h,i)perylene	15	7	1.3	120	14	2	0.068	0.071
Benzo(k)fluoranthene	15	15	0.25	150	14	3	0.078	0.14
Chrysene	15	15	0.78	460	14	7	0.061	0.29
Dibenzo(a,h)anthracene	15	10	0.062	22	14	0		
Fluoranthene	15	13	1	180	14	4	0.056	0.44
Fluorene	15	7	0.17	11	14	0		
Indeno(1,2,3-cd)pyrene	15	13	1.4	93	14	1		0.082
Naphthalene	15	0			14	0		
Phenanthrene	15	14	0.12	39	14	0		
Pyrene	15	15	0.21	160	14	3	0.061	0.07
PCBs								
Aroclor 1016	15	0			14	0		
Aroclor 1221	15	0			14	0		
Aroclor 1232	15	0			14	0		
Aroclor 1242	15	0			14	0		
Aroclor 1248	15	4	0.42	2.1	14	0		
Aroclor 1254	15	0			14	0		
Aroclor 1260	15	0			14	0		
Aroclor 1262	15	0			14	0		
Aroclor 1268	15	3	0.59	0.96	14	0		
TPH								
TPH (HCID)	15	6	NA	NA	14	0		
Diesel by 8015	15	6	280	2200				
Gasoline	15	0						
Heavy Oil	15	0						

* VOCs analyzed but not detected in process residue or native sediment.

HCID = hydrocarbon identification.

NA = not applicable.

Empty cells = not detected.

Source: Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary (CH2M HILL, March 26, 1997).

Table 4-10 Depression East of the Outfall Ditch Soil Results (1996 and 1997)						
Station ID:	CL-SD002	CL-SB041	Background*			
Date Sampled:	10/15/96	9/9/97	Upland Soils		Wetland Soils	
Depth (feet)	0 to 1.5	Surface	Minimum	Maximum	Minimum	Maximum
Analyte (mg/kg)						
Cyanide, Total	1 U	1.01 U	1 U	2.6 U	1 U	3 U
Fluoride by 340.1/2	570	400 J	180	240	120	250
Fluoride By 300.0	20	5 J				
Fluoride (GI extraction)		75 U				
Total Organic Carbon	10500	101000	7950	58100	17400	26100
Total Metals						
Aluminum	25800 J	22400	7270 J	10500	4720 J	14600
Antimony	2.5 UJ	5 U	2.5 U	5.9 U	2.5 U	2.5 J
Arsenic	10.1	4.7	0.984	1.6	1.1	11.9
Barium	152	120	22.8	63	33.8	107
Beryllium	0.78	1 U	0.05 U	0.48 BJ	0.5 U	0.72
Cadmium	1.17	1.8	0.41 U	0.05 U	0.47 U	0.77
Calcium	6440 [J]		2200	2860	2160	3740
Chromium	30.2	25	7.7	11.5	8.65	19.3
Cobalt	12	11.7	2.61	5.1 B	2.5 U	7.21
Copper	46.3	51.2	9.32	18.9 J	7.9 J	28.5
Iron	32300	24500	8160	11800	6190	122000 D
Lead	37.8	12.1	5.4	25.9	0.71 J	28
Magnesium	6120		791	1590	924	3950
Manganese	473	322	68.5	192 J	63.7	252
Mercury	0.2 U	0.11 U	0.2 U	0.08 J	0.09 UJ	0.2 U
Nickel	25.8	27.4	5.9	9.6 J	5.25	15.5
Potassium	2200		240	422	266	1900
Selenium	1 U		0.32 UJ	1 U		1 U
Silver	1 U		0.33 U	1 U	0.37 U	1 U
Sodium	939		363	670	262	647
Thallium	1 U		0.41 UJ	1 U	0.18 U	1 U
Vanadium	71.9	65.2	32.1	58.1	33	125
Zinc	173	114	19.2	102	26.6	140
PAHs						
2-Methylnaphthalene	0.49 U	0.015 U				
Acenaphthene	0.49 U	0.015 U	0.3 U	10 U	0.3 U	0.39 U
Acenaphthylene	0.49 U	0.015 U	0.3 U	10 U	0.3 U	0.39 U
Anthracene	0.49 U	0.015 U	0.3 U	10 U	0.3 U	0.39 U
Benzo(a)anthracene	0.12 J	0.16	0.3 U	10 U	0.3 U	0.027 J
Benzo(a)pyrene	0.13 J	0.21	0.3 U	10 U	0.3 U	0.39 U
Benzo(b)fluoranthene	0.39 J	0.48	0.3 U	10 U	0.3 U	0.39 U
Benzo(g,h,i)perylene	0.16 J	0.31	0.3 U	10 U	0.3 U	0.39 U
Benzo(k)fluoranthene	0.26 J	0.27	0.3 U	10 U	0.036 U	0.3 U
Chrysene	0.29 J	0.42	0.3 U	10 U	0.035 U	0.3 U
Dibenzo(a,h)anthracene	0.49 U	0.096	0.3 U	10 U	0.3 U	0.39 U
Dibenzofuran		0.015 U				
Fluoranthene	0.12 J	0.16	0.3 U	10 U	0.3 U	0.031 J
Fluorene	0.49 U	0.015 U	0.3 U	10 U	0.3 U	0.39 U
Indeno(1,2,3-cd)pyrene	0.14 J	0.26	0.3 U	10 U	0.3 U	0.39 U
Naphthalene	0.01 U	0.015 U	0.3 U	10 U	0.3 U	0.39 U
Phenanthrene	0.49 U	0.038	0.3 U	10 U	0.3 U	0.39 U
Pyrene	0.11 J	0.15	0.3 U	10 U	0.3 U	0.041 J
PCBs						
Aroclor-1016	0.049 U	0.33 U				
Aroclor-1221	0.099 U	0.67 U				
Aroclor-1232	0.049 U	0.33 U				
Aroclor-1242	0.049 U	0.33 U				
Aroclor-1248	0.049 U	0.33 U				
Aroclor-1254	0.049 U	0.33 U				
Aroclor-1260	0.049 U	0.33 U				
Aroclor-1262	0.049 U	0.33 U				
Aroclor-1268	0.049 U	0.33 U				
* = Source: Technical Memorandum DS No. 12: Background Data Summary for RMC-Troutdale (CH2M HILL, December 3, 1996). Note: Available background PCB data included one sample for upland soils and one sample for wetland soils. PCBs were not detected in either sample. B = Below reporting limit and above instrument detection limit. D = Compound run at a dilution to bring the concentration of that compound within the linear range of the instrument. J = estimated value. P = Indicates a greater than 25 percent difference for detected concentrations between the two columns used for analysis. U = undetected. [] = Advisory flag based on professional judgment rather than method protocol. GI extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be bioavailable. Source: Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS, Part 1 (CH2M HILL, December 12, 1997).						

Figures

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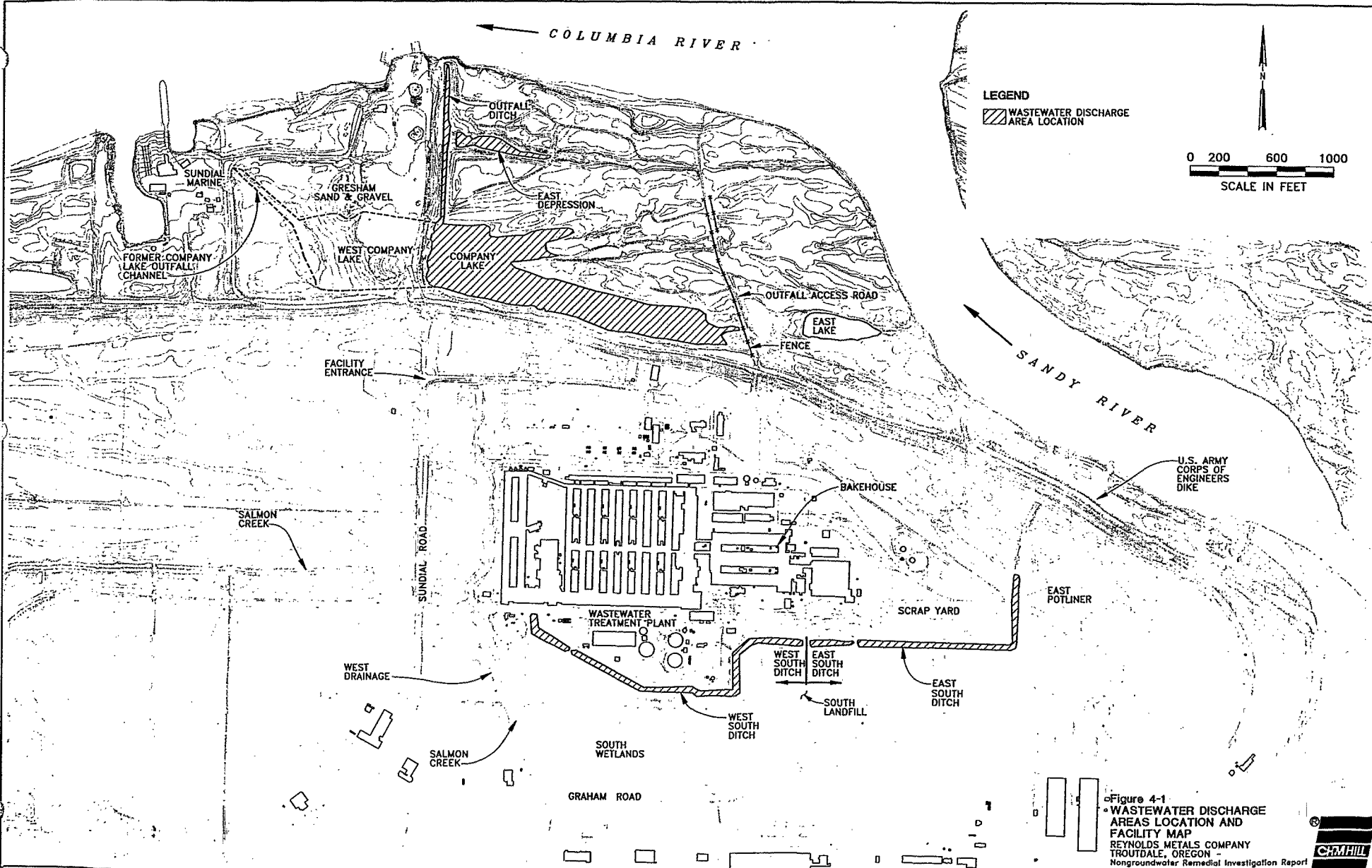
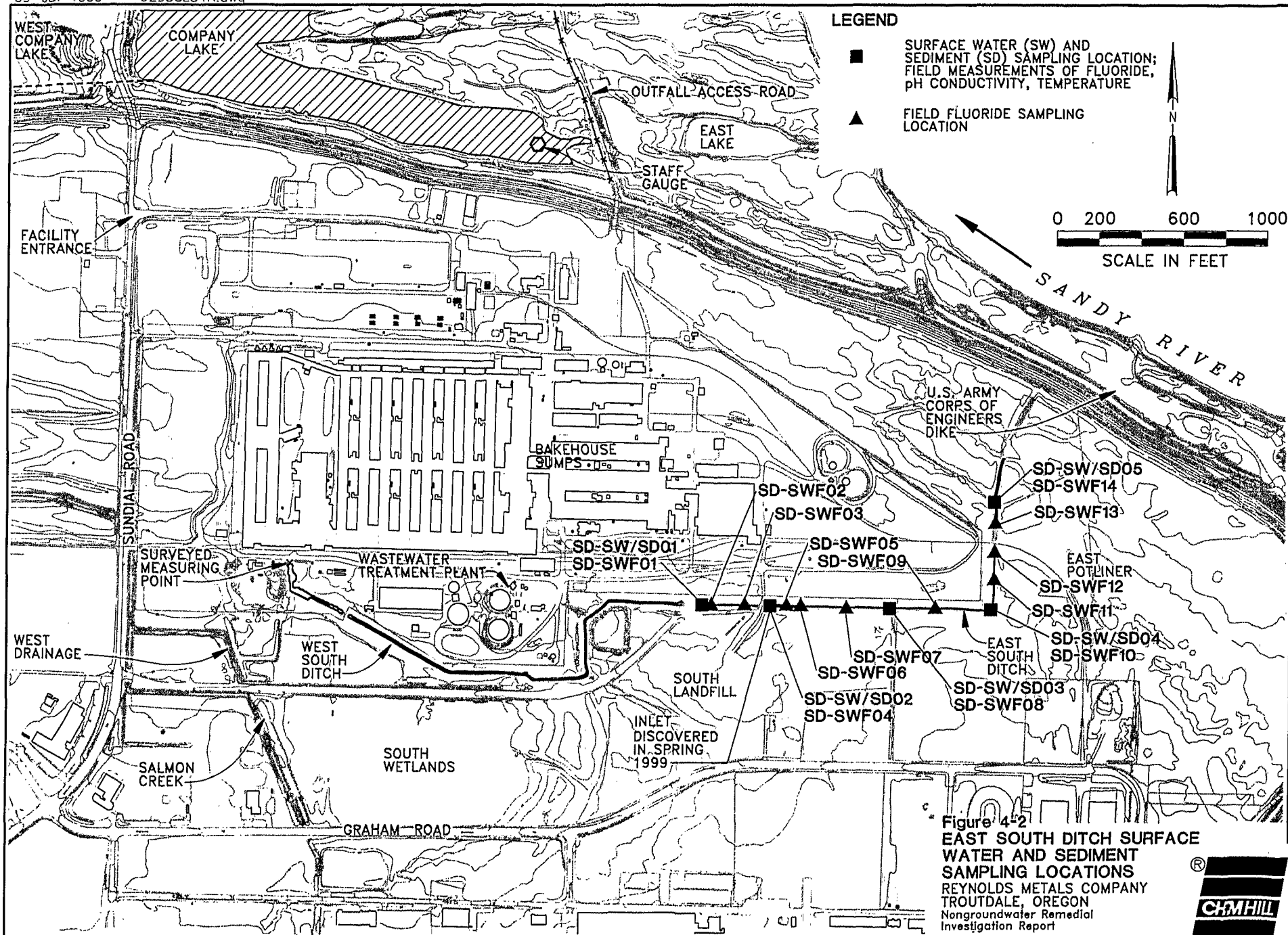


Figure 4-1
 WASTEWATER DISCHARGE
 AREAS LOCATION AND
 FACILITY MAP
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON -
 Nongroundwater Remedial Investigation Report





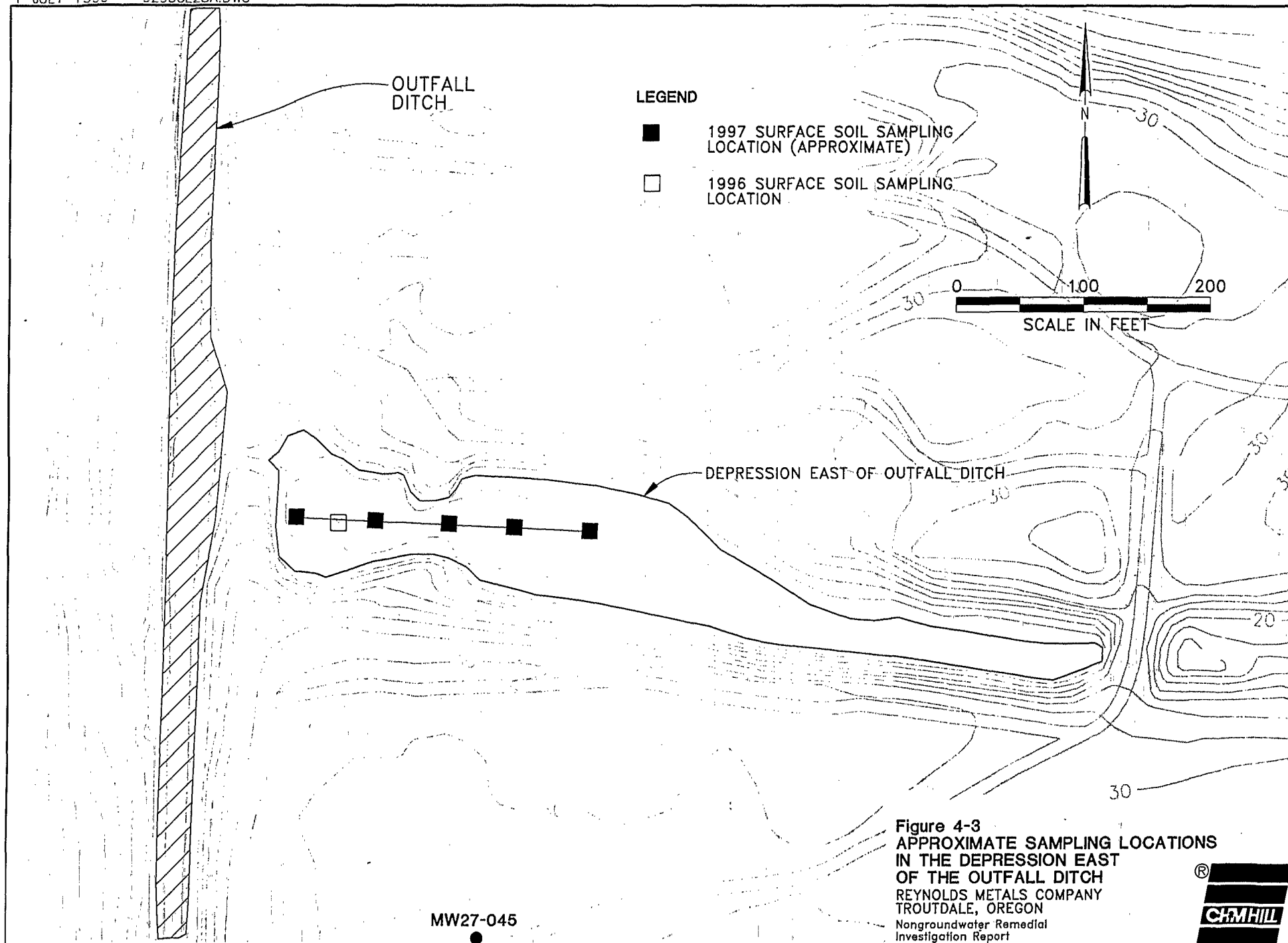


Figure 4-3
APPROXIMATE SAMPLING LOCATIONS
IN THE DEPRESSION EAST
OF THE OUTFALL DITCH
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial
Investigation Report



SECTION 5

Surface Water and Sediment Areas

SECTION 5

Surface Water and Sediment Areas

This section contains a description of the surface water and sediment areas in the vicinity of the Reynolds Metals Company facility and a summary of the results of investigation activities in these areas. The surface water and sediment areas consist of the four water bodies shown in Figure 5-1:

- Columbia River
- Sandy River
- Salmon Creek
- East Lake

More detailed information relating to the surface water and sediment areas can be found in the following documents:

- *Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes* (CH2M HILL, January 1995)
- *Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary* (CH2M HILL, May 10, 1995)
- *Draft Current Situation Summary* (CH2M HILL, April 5, 1996)
- *Memorandum WP No. 29: Columbia and Sandy Rivers Supplemental Data-Gathering Work Plan* (CH2M HILL, August 15, 1996)
- *Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary* (CH2M HILL, January 6, 1997)
- *Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality* (CH2M HILL, February 12, 1997).
- *Technical Memorandum RA No. 4: Fisheries and Aquatic Habitat Characterization* (CH2M HILL, March 31, 1997)
- *Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan* (CH2M HILL, April 3, 1998)

5.1 Columbia and Sandy Rivers

The RMC facility is located southwest of the confluence of the Columbia and Sandy Rivers, as shown in Figure 5-1.

5.1.1 Description of Columbia and Sandy Rivers

The Sandy River forms the eastern boundary of the RMC property. The lower reach of the Sandy River is a shallow, sand delta. The main-stem channel meanders through this delta. During drier periods (late summer and early fall), water flows in sheets across the sand flats. Depths in the lower reach vary with water elevations in the Columbia River and freshwater input.

The Columbia River forms the northern boundary of the RMC property. It is a tidally influenced freshwater river; the depth varies with the tidal cycle, freshwater input, and release of impounded water from the Bonneville Dam, approximately 24 miles upstream of the RMC site. RMC has a permitted NPDES outfall in the Columbia River, just downstream of its confluence with the Sandy River. The NPDES permit allows a mixing zone consisting of a semicircle with a 164-foot radius from the point of discharge. Upstream of the outfall and mixing zone, there is a beach on the Columbia River along the northern part of the property that is used occasionally for recreation by people from the nearby community.

Refractory brick (heat-resistant flue brick used in the baking furnaces) has been used as bank stabilization in two areas along the river shorelines (see Figure 5-2). On the western shore of the Sandy River, a section approximately 300 feet long is covered with refractory brick. A section of the Columbia River shoreline, approximately 100 feet long and centered at the RMC outfall, is also stabilized by refractory brick. This brick extends from beneath the water line to the top of the steep embankment. The refractory brick was identified early in the project as a possible source of contaminants.

Gresham Sand and Gravel (GS&G) operates a sand dredging operation in the Columbia River. GS&G dredges 30 feet offshore, just downstream of the mouth of the Sandy River and just upstream of the outfall from Company Lake. Sand is vacuum dredged and transported, in slurry form, through a pipe to GS&G property immediately west of the outfall ditch and Company Lake.

In the fall of 1996, a fisheries and habitat characterization survey was performed on all the major surface water areas in and around the RMC facility (*Technical Memorandum RA No. 4: Fisheries and Aquatic Habitat Characterization*). The results of the characterization indicate that the most important fisheries resources on or near the site are in the Columbia and Sandy Rivers. The Columbia and Sandy Rivers support numerous anadromous salmon and trout, as well as resident fish species. Many Columbia and Sandy River fisheries are a significant economic and recreational commodity. In addition, ten species of special-status fish may occur in or migrate by the RMC area. "Special-status fish" include those considered by federal agencies to be endangered, threatened, candidates for listing, or species of concern, as well as fish considered by the states of Oregon or Washington to be sensitive or threatened.

The habitat of the Columbia River in the vicinity of the RMC facility is primarily shallow-water, near-shore rearing areas and deeper, offshore areas used for fish rearing and passage. The Sandy River habitat survey was conducted slightly upstream of the confluence with the Columbia River and extended up the Sandy River approximately 1.8 miles to the upstream RMC property boundary. No salmon spawning habitat was present within the portion of the river from the confluence with the Columbia River upstream to the RMC southern property boundary. The reaches of the Columbia and Sandy Rivers adjacent to the RMC

facility are areas of high disturbance and are not expected to have a significant abundance or diversity of benthic (bottom-dwelling) invertebrates. These disturbances are both natural and manmade: the Sandy River has a dynamic delta of shifting sandbars, and intentional dredging of this deposited sand is conducted in the Columbia River just downstream of the Sandy River mouth.

Groundwater flow at the RMC site is generally from the southeast to the north-northwest in the sand units. The Columbia and Sandy Rivers represent local and regional groundwater discharge zones.

5.1.2 Summary of Investigations at Columbia and Sandy Rivers

Numerous investigations have been conducted at both the Columbia and Sandy Rivers. Table 5-1 summarizes investigations of surface water, sediment, and soil at the Columbia River. Table 5-2 summarizes investigations of surface water, sediment, and soil at the Sandy River.

Additional investigations have been completed to evaluate the potential migration of constituents via groundwater discharge to the Columbia and Sandy Rivers. Table 5-3 summarizes groundwater investigations and findings at both rivers. More detailed information on sitewide groundwater can be found in the *Draft Groundwater Remedial Investigation Report* (CH2M HILL, June 1999).

5.1.3 Nature and Extent of Chemical Constituents at Columbia and Sandy Rivers

This section presents a discussion of the nature and extent of chemical constituents at the Columbia and Sandy Rivers.

5.1.3.1 Columbia River

Table 5-4 presents a summary of concentration ranges for selected constituents in Columbia River surface water, sediment, and riparian soil adjacent to the RMC site. The key results are summarized in Table 5-1. A comparison of these concentrations to background concentrations is provided in *Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary*. Figure 5-2 shows sample locations for the rivers.

5.1.3.2 Sandy River

Table 5-5 presents a summary of concentration ranges for selected constituents in Sandy River surface water, sediment, and riparian soil adjacent to the RMC site. The key results are summarized in Table 5-2. A comparison of these concentrations to background concentrations is provided in *Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary*.

5.1.4 Fate and Transport Issues at Columbia and Sandy Rivers

This section provides a discussion of the potential migration of onsite constituents to the Columbia and Sandy Rivers.

5.1.4.1 Columbia River

There are four potential constituent migration pathways from the RMC site to the Columbia River.

- The Columbia River receives discharge from the Company Lake outfall ditch. It is possible that sediment in Company Lake may be transported to the Columbia River under extreme flood conditions. See Section 4.2 of this document for more information on Company Lake.
- The Columbia River receives discharge from Salmon Creek, downstream of the Company Lake outfall. See Section 5.2 of this document for more information on Salmon Creek.
- Refractory brick, located at the Company Lake outfall to the Columbia River, may contribute constituents through leaching, scouring, or erosion.
- The Columbia River is a local and regional groundwater discharge area and receives both shallow and deep groundwater from the RMC site and surrounding areas. See the *Draft Groundwater Remedial Investigation Report* for more groundwater information.

Brick: RMC has conducted testing on "dirty" brick, which are bricks removed directly from the bakehouse [see *Technical Memorandum DS No. 15: Company Lake Supplemental Data Summary* (CH2M HILL, March 26, 1997)]. Results indicate that the brick particulates could contribute low levels of metals and PAHs, although the contribution of weathered brick is expected to be less. The analytical results for interstitial brick soil and sediment adjacent to the brick were similar to background levels, confirming that the bricks are a minor pathway.

Toxicity characteristic leaching procedure (TCLP) leach tests of dirty brick suggest that low levels of metal may leach from refractory brick to surface water. However, this is expected to be a minor pathway: the TCLP method overestimates constituent contributions from existing shoreline brick because it uses a strong acid solution. Furthermore, the method was used on brick taken directly from the bakehouse in contrast to the weathered brick along the rivers.

Groundwater: The area along the rivers where fluoride concentrations in groundwater are greater than 4 mg/L is limited in extent and is found only in the shallow upper gray sand (UGS) and intermediate-depth sand. Fluoride is likely discharging at concentrations above 4 mg/L (10 to 13 mg/L) from the upper gray sand (UGS) into the Columbia River near the Company Lake outfall and from a smaller area of the intermediate sand east of the Company Lake outfall. See Section 4 of the *Draft Groundwater Remedial Investigation Report* for a more complete description.

Mixing calculations for the Columbia River estimate that even under the most conservative river flow conditions (7Q10¹), the mixing factor ranges between about 34,000 (assuming 20 percent of the river flow is available for mixing) and 84,000 (assuming 50 percent of the river flow is available for mixing) (see Appendix D of the *Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan*). The mixing factors increase for higher river flow rates and for higher percentages of the river flow available for mixing.

¹ The 7-day sustained low flow over a 10-year period.

Using measured groundwater data adjacent to the Columbia River (concentrations ranged from 0.27 to 13 mg/L fluoride), the increase in the in-stream fluoride concentrations is predicted to be extremely low (maximum concentration of 0.00005 mg/L). Based on predicted concentrations, it is not expected that this increase in fluoride would be detected because these concentrations are below standard analytical detection limits (typically 0.1 to 0.5 mg/L).

5.1.4.2 Sandy River

There are two potential constituent migration pathways from the RMC site to the Sandy River.

- Refractory brick, located along approximately 300 feet of the western shore of the Sandy River, may contribute constituents through leaching, scouring, or erosion.
- The Sandy River is a groundwater discharge area and receives both shallow and intermediate groundwater from the RMC site and surrounding areas.

TCLP leach tests of fresh "dirty" brick suggest that low-level metals may leach from refractory brick to surface water, although this is expected to be a minor pathway because the TCLP method likely overestimates the potential contribution from brick.

Fluoride concentrations in groundwater near the Sandy River exceed 4 mg/L in the shallow UGS but not in the intermediate-depth sand units. Fluoride is likely discharging at concentrations slightly above 4 mg/L from the UGS into the Sandy River in a localized area near the old East Lake channel. There is also a potential for metal constituents to be discharging to the Sandy River, based on data from monitoring wells.

Mixing calculations for the Sandy River estimate that even under the most conservative flow conditions (7Q10), the mixing factor ranges from about 90 (assuming 10 percent of the flow is available for mixing) to 450 (assuming 50 percent of the flow is available for mixing). The mixing factors increase for higher river flow rates and for higher percentages of the river flow that are available for mixing.

Using measured groundwater data adjacent to the Sandy River (concentrations ranged from 0.25 to 4.36 mg/L fluoride), the increase in the in-stream fluoride concentrations is predicted to be low (maximum concentration of 0.006 mg/L). Based on predicted concentrations, it is not expected that fluoride will be detected because these concentrations are below standard analytical detection limits (0.1 to 0.5 mg/L). In-stream measurements adjacent to the site confirm these calculated predictions; fluoride has not been detected in the Sandy River.

5.2 Salmon Creek

Figure 5-1 shows the location of Salmon Creek.

5.2.1 Description of Salmon Creek

Salmon Creek flows along a section of the southwest border of the RMC property and is pumped into the Columbia River from an equalization pond west of Fairview Farms. The equalization pond traps sediments from Salmon Creek, preventing their discharge to the Columbia River.

Salmon Creek serves as stormwater conveyance for parts of the City of Troutdale, the City of Wood Village, and the City of Fairview. The Blue Lake watershed also drains into Salmon Creek through a control pipe near the equalization pump. Salmon Creek water quality may be affected by urban, industrial, and Troutdale Airport stormwater, groundwater, and past and current discharges from RMC. Potential sources of constituents to Salmon Creek enter both upstream and downstream of the RMC facility, in addition to the discharge from the RMC facility.

Recreational use of the reach of the creek near RMC property is not likely because of a lack of access and periodic dredging operations by the drainage district to maintain capacity. The ecological habitat is primarily for waterfowl and terrestrial wildlife and resident species; benthic habitat is poor because the creek is dredged on a regular basis, and anadromous fish are prevented from entering the creek by the pump station.

From 1941 to 1947, wastewater from the RMC facility was treated for solids removal in south wetlands, and overflow from south wetlands was discharged to Salmon Creek. There was no wastewater discharge from south wetlands to Salmon Creek after 1947; all south wetlands wastewater overflow was redirected to Company Lake at that time. South wetlands stopped being used as a settling pond in 1965. Salmon Creek was rerouted between 1966 and 1968, and stormwater runoff from south wetlands was routed into Salmon Creek via West Drainage. West Drainage flows into Salmon Creek only during wet weather conditions.

Salmon Creek is a low-gradient, low-flow channel with silt, clay, and organic debris substrate (except near culverts where gravel was placed during culvert installation). There are also areas of dense aquatic vegetative growth. Salmon Creek is a gaining stream (groundwater flows into the creek) in the winter and spring when groundwater is high. During summer and fall, the creek becomes a losing stream and discharges to groundwater.

5.2.2 Summary of Investigations at Salmon Creek

Table 5-6 summarizes investigations for surface water and sediment and the specific elements of the groundwater program relevant to Salmon Creek.

5.2.3 Nature and Extent of Chemical Constituents at Salmon Creek

This section presents a discussion of the nature and extent of chemical constituents at Salmon Creek. Figure 5-3 is a map of sampling locations.

Table 5-7 summarizes concentration ranges for selected constituents in Salmon Creek surface water and sediment. The key results are summarized in Table 5-6. A comparison of these concentrations to background concentrations is provided in Appendix E of the *Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan*.

5.2.4 Fate and Transport Issues at Salmon Creek

Water in Salmon Creek is a combination of urban, agricultural, and industrial stormwater, as well as groundwater discharge. The primary pathways for constituent migration from the RMC site to Salmon Creek are from shallow groundwater and surface water from south wetlands via West Drainage during wet periods.

South wetlands is well vegetated, which minimizes transport of sediment via West Drainage. Monitoring of stormwater indicates that total suspended solids are less than 30 mg/L during rain events. Upstream sources not related to RMC appear to be contributing to sediment concentrations: metals, PCBs, TPH, and PAHs were detected upstream of the West Drainage confluence. Constituents that appear to be higher downstream of the confluence are fluoride, aluminum, and PAHs.

In surface water, the potential constituents that could migrate from south wetlands during storm events include fluoride and metals. Upstream sources not related to RMC appear to be contributing to surface water concentrations: metals and low-level PAHs were detected upstream of the West Drainage confluence. Fluoride and some dissolved metal concentrations (aluminum, copper, and iron) were higher downstream of the confluence during one storm event but not during the second event. The volume of flow in Salmon Creek during these events and the limited contribution of surface water from West Drainage probably affect an ability to detect any difference.

The peak stormwater flows from West Drainage are a relatively small percentage of the peak storm flows in Salmon Creek. Even under a 2-year storm, the Salmon Creek peak flow is estimated at 248 cubic feet per second (cfs), while the peak storm flows measured in West Drainage were approximately 2 cfs, or less than 1 percent of the flow. If there is a detectable increase in concentrations of constituents immediately downstream of West Drainage, this effect would be limited to a small area downstream because of the much greater flows in the creek. Additional flows into Salmon Creek downstream of the RMC facility also decrease the ability to detect any measurable effect on water quality, given that the flow in Salmon Creek near RMC is less than half of the flow that discharges to the Columbia River.

Salmon Creek is a gaining stream (groundwater flows into the creek) in the winter and spring when groundwater is high. A transition period occurs between mid-June and mid-July as groundwater drops below the surface water elevation. During late summer and fall, Salmon Creek becomes a losing stream and recharges groundwater.

Estimated groundwater flow into Salmon Creek is approximately 1.27×10^{-4} cfs in the winter/spring. This indicates that the likely contribution of groundwater to Salmon Creek is very small and suggests that the potential for constituent contribution from groundwater is low. (For further discussion, see the memorandum contained in Appendix E of the *Draft Surface Water and Sediment Work Plan Addendum*.)

The results of groundwater samples collected just west of Salmon Creek north of Graham Road were compared with surface water samples collected upstream of the confluence of West Drainage and Salmon Creek, where surface water is not influenced by surface water discharges from RMC. The comparison suggests there is likely a contribution of dissolved metals in surface water from upstream of RMC. However, there are no background dissolved metals results available for surface water to evaluate the upstream contribution of metals.

Overall, it appears that the constituent concentrations observed in surface water and shallow groundwater are similar. Because the flows in Salmon Creek are so much greater (for example, 248 cfs for a 2-year storm event) than the flows contributed by groundwater (maximum 1×10^{-4} cfs), the metals detected in Salmon Creek upstream of the West

Drainage confluence are probably from upstream sources. Any contribution from groundwater would be difficult to detect.

See Appendix E of the *Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan* for a more complete discussion of groundwater and surface water interactions at Salmon Creek.

5.3 East Lake

5.3.1 Description of East Lake

East Lake is located north of the COE flood control dike in the Columbia River 100-year floodplain, approximately 600 feet east of Company Lake (Figure 5-1). The area is unfenced, although thick blackberries surround most of the lake and make accessibility by people difficult. During unusually high water periods in the Sandy River, water from the Sandy River flows into East Lake; otherwise, there are no inlets or outlets to the lake. There is little aquatic vegetation in the lake, and reed canarygrass and Himalayan blackberries are the dominant riparian plants.

The appearance of the water in East Lake and the water quality have been observed to be highly variable. Water levels in East Lake are probably affected by both local groundwater elevations and river water elevations during periods of high water.

Current and future use of East Lake is as an ecological habitat, primarily for migratory waterfowl and terrestrial wildlife. East Lake is not a viable fishery habitat. Residential, commercial, or other industrial uses are unlikely because of the area's current zoning, location north of the COE dike, and the possibility of flood. Recreational use is unlikely because of the lake's inaccessibility, lack of fisheries, shallowness, and soft substrate. In fall 1996, a fisheries and habitat characterization survey indicated that there is little suitable fish habitat in East Lake (*Technical Memorandum RA No. 4: Fisheries and Aquatic Habitat Characterization*).

During the 1994 investigation, water clarity was high. During 1996, after the February 1996 floods, organic debris had been deposited in the lake and water clarity was extremely low. The sediment appeared to be anoxic, judging by the rotten odor and escaping gas. The presence of anoxic sediment suggests that dissolved oxygen levels in the water column were low. Field observations of the lake during the 1998 investigation indicate that the lake was returning to pre-flood conditions. Water clarity had increased, although it was still somewhat turbid, and oxygen measurements were high.

5.3.2 Summary of Investigations at East Lake

Table 5-8 summarizes investigations for surface water and sediment, and the specific elements of the groundwater program relevant to East Lake.

5.3.3 Nature and Extent of Chemical Constituents at East Lake

Table 5-9 summarizes concentration ranges for selected constituents in East Lake surface water and sediment. The full data set of concentrations and a comparison to background

concentrations is provided in Appendix F of the *Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan*. A sample location map is also provided in that document.

5.3.4 Fate and Transport Issues at East Lake

In general, East Lake does not pose a potential impact to surface water or groundwater onsite. The potential pathways of constituent migration from the RMC site to East Lake are via groundwater (during unusually high groundwater periods) and surface water. East Lake was likely connected to Company Lake sometime before 1957, when the road between the two water bodies was improved. Aerial photographs show a road between the two water bodies as early as 1918, but it is unknown whether the road at that time allowed movement of Company Lake water toward East Lake. The natural movement of water would probably have been from the Sandy River to East Lake, to Company Lake, and then to the Columbia River. This situation would have minimized transport from Company Lake to East Lake.

Groundwater data from two Geoprobe and one monitoring well were used to assess the potential for groundwater in the area to have an adverse effect on East Lake. The maximum fluoride values detected at the two Geoprobe locations were 4.36 mg/L at 42 feet bgs, and 7.35 mg/L at 72 feet bgs, approximately 32 and 67 feet below the bottom of the lake, respectively. Fluoride was detected at 2.32 mg/L at a nearby monitoring well (approximately 20 feet below the bottom of the lake). Because of the perched nature of East Lake, the resulting downward hydraulic gradient, and the low fluoride concentration in the shallow groundwater in the vicinity of the lake, the potential for groundwater to adversely affect East Lake is low.

Tables

Table 5-1
Summary of Investigations at the Columbia River

Investigation	Purpose	Description	Key Findings	Reference
Removal Site Assessment (1994)	Evaluate nature and extent	Two sediment samples and one surface water sample were collected adjacent to the NPDES outfall. All samples were collected within the permitted mixing zone.	Sediments: No cyanide (CN), polychlorinated biphenyls (PCBs), or total petroleum hydrocarbons (TPH) were detected. Metals and polynuclear aromatic hydrocarbons (PAHs) within range of background, except sodium slightly higher. Fluoride (F) was detected in one sample. Surface water: No F, CN, PAHs, or PCBs were detected. Metals within range of background, except aluminum higher at outfall (within permitted mixing zone).	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
NPDES Outfall Soil Sampling (1995)	Investigate interstitial material within brick	One riparian soil sample was collected within refractory brick at the RMC outfall to the Columbia River.	One PAH compound and F were detected. CN was not detected.	<i>Memorandum WP No. 29: Columbia and Sandy Rivers: Supplemental Data-Gathering Work Plan</i> (CH2M HILL, August 15, 1996)
Columbia and Sandy Rivers Supplemental Data Collection (1996)	Evaluate effect of brick along shoreline	Three sediment samples were collected: One sample was adjacent to the refractory brick area (within the permitted mixing zone), and two samples were upstream of the brick area (upstream of the mixing zone). Two riparian soil samples were collected: One sample within refractory brick area and one sample outside of the brick area.	Sediments: No CN, PCBs, PAHs or other semivolatile organic compounds (SVOCs) were detected. Metals within range of background, except sodium slightly higher. F (using shake-out method) was not detected in samples outside of the mixing zone; F was detected within the mixing zone at concentrations similar to 1994 investigation. Riparian soil: No CN, PAHs, SVOCs, or PCBs were detected. The sample within the brick area was slightly higher in fluoride than samples outside of the brick area. Metals were within the range of background.	<i>Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary</i> (CH2M HILL, January 6, 1997)

Table 5-2
Summary of Investigations at the Sandy River

Investigation	Purpose	Description	Key Findings	Reference
Supplemental Data Gathering in East Potliner Area (1995)	Investigate potential migration from east potliner area to Sandy River	Three sets of surface water and sediment samples were collected.	No CN or PAHs detected in surface water or sediments. No F detected in surface water. F and benzoic acid detected in sediments.	<i>Technical Memorandum DS No. 3: East Potliner Area: Supplemental Data-Gathering Summary</i> (CH2M HILL, June 15, 1995)
Columbia and Sandy Rivers Supplemental Data Collection (1996)	Evaluate nature and extent; evaluate effect of brick along shoreline; evaluate groundwater discharge influence on surface water	Three surface water samples were collected: one along the east bank (upstream sample) and two along the west bank adjacent to refractory brick. Six sediment samples were collected adjacent to, upstream, and downstream of the refractory brick area. Four riparian soil samples were collected: three within and one upstream of the refractory brick.	<p>Surface water: F, PAHs, and PCBs not detected. CN detected in the upstream sample. Most dissolved metals not detected. One sample collected in backwater believed to be representative of groundwater discharge; showed higher concentrations of major cations.</p> <p>Sediment: PAHs and PCBs not detected. CN detected in one sample near detection limit. F detected in similar concentrations upstream, adjacent to, and downstream of brick area. Metal concentrations similar to Columbia River background.</p> <p>Riparian soils: CN, PAHs, and PCBs not detected. Fluoride slightly elevated in brick area compared to upstream sample. Metals similar to background concentrations.</p>	<i>Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary</i> (CH2M HILL, January 6, 1997)

Table 5-3
Summary of Groundwater Investigations at the Columbia and Sandy Rivers

Investigation	Purpose	Description	Key Findings	Reference
Water Elevation Data Collection (1994-1997)	Determine groundwater/surface water interactions at river boundaries	Water level elevation data were collected manually, on a monthly basis, from 1994-1997.	Groundwater (GW) flow beneath the site is generally north to northwest toward the Columbia River. May 1997 data showed gradient reversals across the site due to high river stage conditions. In areas near the Sandy River, shallow groundwater discharges to the Sandy River, but deeper GW discharges to the Columbia.	<i>Appendix C: Analysis of River Stage Fluctuations and Effects on Nearby Groundwater Elevations, in Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan (CH2M HILL, April 3, 1998)</i>
Geoprobe Investigation (1997)	Monitor fluoride in GW discharging to the Columbia and Sandy Rivers	Geoprobe borings were installed to collect subsurface data at 22 locations along the rivers.	Fluoride concentrations along the river shorelines ranged from nondetect to 13 mg/L. The two highest concentrations (12 mg/L and 13 mg/L) were found north of Company Lake. The highest concentration found north of the dike was located west of Company Lake (18.6 mg/L).	<i>Technical Memorandum No. GW-12: August 1997 Quarterly Groundwater Monitoring Results (CH2M HILL, December 18, 1997)</i>
Groundwater Discharge Mixing Calculations (1998)	Assess potential exposure concentrations in the rivers	Calculations were completed using four different scenarios to estimate mixing factors and resulting fluoride concentrations under mixed conditions.	Using average measured groundwater data adjacent to the rivers, predicted increase in the in-stream fluoride concentrations is extremely low (maximum of 0.00005 mg/L in the Columbia River, maximum of 0.006 mg/L in the Sandy River). In-stream measurements adjacent to the site confirm these calculated predictions: fluoride has not been detected in the rivers.	<i>Appendix D: Mixing Calculations for Groundwater Discharges into the Columbia and Sandy Rivers, in Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan (CH2M HILL, April 3, 1998)</i>

Table 5-4
Summary of Surface Water, Sediment, and Riparian Soil Data at the Columbia River, Adjacent to the RMC Site
(1994, 1995, and 1996)

Analyte	Surface Water (mg/L)	Sediment ^b (mg/kg)			Riparian Soil ^c (mg/kg)		
		Minimum	Maximum	No. of Samples	Minimum	Maximum	No. of Samples
Inorganic Compounds							
Cyanide, Total	0.01 U	0.1 U	1 U	5	1 U	1 U	3
Fluoride (340.1/.2)		170	240	3	210	340	3
Fluoride (340.2M)	0.5 U	2.5 U	13	5	2.5 U	4	2
Total Metals							
Aluminum	0.74	3430	6800	5	9500	11100	2
Arsenic	0.004 U	0.5 U	2.5	5	1.2	1.7	2
Barium	0.02 U	19.2	66	5	49.4	51.4	2
Copper	0.02 U	7.55	12	5	17.2	17.8	2
Iron	0.48	6810	14000	5	13400	16600	2
Lead	0.004 U	5 U	5 U	5	5 U	5.8	2
Magnesium	4.6	1070	2500	5	2620	2780	2
Manganese	0.02 U	82.1	170	5	166	235	2
Nickel	0.05 U	5.51	14	5	11.2	14.3	2
Vanadium	0.02 U	24.9	35.2	5	41.6	48.2	2
Zinc	0.05 U	16.6	59	5	32.2	34.2	2
PAHs							
Acenaphthene	0.005 U	0.0067 U	2.9 UR	5	0.3 U	2.5 UR	3
Acenaphthylene	0.005 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Anthracene	0.005 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Benzo(a)anthracene	0.0001 U	0.0067 U	0.013	5	0.3 U	0.33 UJ	3
Benzo(a)pyrene	0.0001 U	0.0067 U	0.021	5	0.3 U	0.33 UJ	3
Benzo(b)fluoranthene	0.0001 U	0.33 UJ	0.048	5	0.33 UJ	0.4	3
Benzo(g,h,i)perylene	0.0001 U	0.0067 U	0.022	5	0.3 U	0.33 UJ	3
Benzo(k)fluoranthene	0.0001 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Chrysene	0.0001 U	0.33 UJ	0.033	5	0.3 U	0.33 UJ	3
Dibenzo(a,h)anthracene	0.0001 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Fluoranthene	0.0001 U	0.33 UJ	0.023	5	0.3 U	0.33 UJ	3
Fluorene	0.005 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Indeno(1,2,3-cd)pyrene	0.0001 U	0.0067 U	0.017	5	0.3 U	0.33 UJ	3
Naphthalene	0.005 U	0.0067 U	0.33 UJ	5	0.3 U	0.33 UJ	3
Phenanthrene	0.005 U	0.0067 U	0.017	5	0.3 U	0.33 UJ	3
Pyrene	0.0005 U	0.019	0.023	5	0.3 U	0.33 UJ	3
PCBs							
Total PCBs	ND	ND	ND	2	ND	ND	2
Conventional Compounds							
TOC		1950	8900	5	5740	5920	2

^a Source: Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes (CH2M HILL, January 1995).

Data represent one surface water sample located within the NPDES mixing zone.

^b Sources: Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes and Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary (CH2M HILL, January 6, 1997).

^c Sources: Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes and Memorandum WP No. 29: Columbia and Sandy Rivers Supplemental Data-Gathering Work Plan (CH2M HILL, August 15, 1996).

J = estimated value.

R = Result is rejected due to gross QA/QC outliers; presence or absence of material cannot be certain.

U = undetected.

ND = All analytes were not detected.

Table 5-5
Summary of Surface Water, Sediment, and Riparian Soil Data at the Sandy River, Adjacent to the RMC Site (1995 and 1996)

Analyte	Surface Water ^a (mg/L)			Sediment ^a (mg/kg)			Riparian Soil ^b (mg/kg)		
	Minimum	Maximum	No. of Samples	Minimum	Maximum	No. of Samples	Minimum	Maximum	No. of Samples
Inorganic Compounds									
Cyanide, Total	0.01U	0.09	6	0.1 U	1.1	9	1 U	1 U	4
Fluoride (340.1/2)				130 U	330	9	220	350	4
Fluoride (340.2M)	0.5U	0.5U	3	2.5 U	3	6	2.5 U	11	4
Fluoride (300.0)	0.25U	0.25U	3						
Metals									
	Dissolved	Total		Dissolved	Total		Total	Total	
Aluminum	0.05 U	0.17	3,3	0.05 U	0.578	6	8340	16000	4
Arsenic	0.004 U	0.004 U	3,3	0.004 U	0.004 U	6	1.1	1.9	4
Barium	0.02 U	0.02 U	3,3	0.02 U	0.02 U	6	53.2	98.2	4
Copper	0.002 U	0.002 U	3,3	0.002 U	0.002 U	6	16.5	24.2	4
Iron	0.107	0.225	3,3	3.29	6.12	6	13200	22100	4
Lead	0.001 U	0.001	3,3	0.001 U	0.0018	6	6.5	10	4
Magnesium	2.29	2.31	3,3	11.1	11	6	2670	3840	4
Manganese	0.02 U	0.02 U	3,3	1.91	1.78	6	5.4	8.1	4
Nickel	0.04 U	0.04 U	3,3	0.04 U	0.04 U	6	2130	3390	4
Vanadium	0.02 U	0.02 U	3,3	0.02 U	0.02 U	6	186	301	4
Zinc	0.05 U	0.05 U	3,3	0.05 U	0.05 U	6	10.9	17	4
PAHs									
Acenaphthene	0.0001U	0.001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Acenaphthylene	0.0001U	0.003U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Anthracene	0.0001U	0.0002U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Benzo(a)anthracene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Benzo(a)pyrene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Benzo(b)fluoranthene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Benzo(g,h,i)perylene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Benzo(k)fluoranthene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Chrysene	0.0001U	0.0001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Dibenzo(a,h)anthracene	0.0001U	0.0002U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Fluoranthene	0.0001U	0.0005U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Fluorene	0.0001U	0.0005U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Indeno(1,2,3-cd)pyrene	0.0001U	0.0002U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Naphthalene	0.0001U	0.001U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Phenanthrene	0.0001U	0.0002U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
Pyrene	0.0001U	0.0002U	6	0.33 UJ	0.5 U	9	0.33 UJ	0.33 UJ	4
SVOCs									
Benzoic acid				3.3	5.3	3			
PCBs									
Total PCBs	ND	ND	3	ND	ND	6	ND	ND	4
Conventional Compounds									
TOC				11800	24300	6	5120	30200	4

^aSources: Technical Memorandum DS No. 3: East Potliner Area: Supplemental Data-Gathering Summary (CH2M HILL, June 15, 1995), and Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary (CH2M HILL, January 6, 1997).

^bSource: Technical Memorandum DS No. 13: Columbia and Sandy Rivers Supplemental Data Summary.

J = estimated value.

U = undetected.

ND = All aroclors were not detected.

Table 5-6
Summary of Investigations at Salmon Creek

Investigation	Purpose	Description	Key Findings	Reference
Removal Site Assessment (1994)	Evaluate nature and extent in Salmon Creek	One surface water and three sediment samples were collected downstream of the confluence with the West Drainage.	<p>Surface Water: No cyanide (CN), fluoride (F), polynuclear aromatic hydrocarbons (PAHs), polycyclic biphenyls (PCBs), or total petroleum hydrocarbons (TPHs) were detected.</p> <p>Sediment: Fluoride (shake-out method) was not detected. CN and PCBs each detected once in sediment. TPH and metals generally within background ranges. PAHs detected in all sediment samples.</p>	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
West Drainage Sampling Program (1995)	Evaluate West Drainage discharge quality and quantity	One set of surface water and sediment samples was collected upstream and one set downstream of the confluence with the West Drainage.	<p>Surface Water: No CN or PCBs were detected in surface water. F was detected in surface water sample downstream of the West Drainage. Low-level PAHs and TPH were detected in sample located upstream of the West Drainage.</p> <p>Sediment: CN was not detected. F (total method) was detected downstream. One species of PCB was detected in the upstream sample. PAHs were detected in both the upstream and downstream samples.</p>	<i>Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary</i> (CH2M HILL, May 10, 1995)
West Drainage Stormwater Monitoring Program (1996)	Evaluate nature and extent in West Drainage	One set of surface water samples was collected in Salmon Creek above and below the West Drainage confluence during two different storm events (total of four samples).	F was detected upstream and downstream of the West Drainage confluence during one event. No CN, PCBs, or TPHs detected. Low-level PAHs detected both upstream and downstream of the West Drainage confluence. Dissolved metals greater downstream during one storm event but not during the second event.	<i>Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1—Soil, Surface Water, and Groundwater Quality</i> (CH2M HILL, February 12, 1997)
Water Elevation Collection (1997)	Determine groundwater/surface water interactions at Salmon Creek.	Water level elevation data were collected on a weekly basis from May 29 through September 25, 1997 at monitoring wells, staff gages, and the Columbia River.	Groundwater interaction with Salmon Creek is limited to the shallow silt unit. Salmon Creek is a gaining stream in the winter and a losing stream during late summer and fall. Likely contribution of groundwater to Salmon Creek is small and potential for constituent contribution to the creek from GW is low.	<i>Appendix E: Groundwater/Surface Water Interaction at Salmon Creek, in Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan</i> (CH2M HILL, April 3, 1998)
Geoprobe Investigation (1997)	Monitor fluoride in GW adjacent to Salmon Creek	One Geoprobe boring installed to collect subsurface data adjacent to Salmon Creek.	Maximum fluoride concentration of 1.16 mg/L detected at depth of 10 feet bgs.	<i>Technical Memorandum No. GW-12: August 1997 Quarterly Groundwater Monitoring Results</i> (CH2M HILL, December 18, 1997)

Table 5-7
Summary of Surface Water and Sediment Data at Salmon Creek (1994, 1995, and 1996)

	Surface Water ^a (mg/L)				No. of Samples	Sediment ^b (mg/kg)		
	Minimum		Maximum			Minimum	Maximum	No. of Samples
Analyte								
Inorganic Compounds								
Cyanide, Total	0.01U		0.02U		7	0.042 U	2.2	5
Fluoride (340.1/2)	0.25U		0.66		4	150 U	380	2
Fluoride (340.2M)	0.5U		1		3	5 U	5 U	3
Metals	Dissolved	Total	Dissolved	Total		Total	Total	
Aluminum	0.05 U	0.14	0.232	5.35	4,7	1500	17000	5
Arsenic	0.004 U	0.004 U	0.004 U	0.004 U	4,7	1 U	4	5
Barium		0.02 U		0.02 U	3	6.3	88	5
Copper	0.002 U	0.0062	0.0039	0.0146	4,7	3.8	57	5
Iron	0.18	0.4	0.457	7.67	4,7	3700	25000	5
Lead	0.001 U	0.002	0.001 U	0.0093	4,7	2.5 U	32	5
Magnesium		5.8		6.2	3	170	2600	5
Manganese		0.02 U		0.068	3	24	200	5
Nickel	0.04 U	0.04 U	0.04 U	0.05 U	4,7	4.1	44	5
Vanadium	0.02 U	0.02 U	0.02 U	0.024	4,7	12	80	5
Zinc	0.05 U	0.05 U	0.05 U	0.0712	4,7	10	260	5
PAHs								
Acenaphthene	0.0001U		0.005U		7	0.0067 U	0.02	5
Acenaphthylene	0.0001U		0.005U		7	0.0067 U	0.067 U	5
Anthracene	0.0001U		0.005U		7	0.0067 U	0.077	5
Benzo(a)anthracene	0.0001U		0.0001U		7	0.02	0.92	5
Benzo(a)pyrene	0.0001U		0.0001U		7	0.031	1.1	5
Benzo(b)fluoranthene	0.0001U		0.00011		7	0.073	2.5	5
Benzo(g,h,i)perylene	0.0001U		0.0001		7	0.017	0.88	5
Benzo(k)fluoranthene	0.0001U		0.0001U		7	0.014	0.56	5
Chrysene	0.0001U		0.0001U		7	0.03	1	5
Dibenzo(a,h)anthracene	0.0001U		0.0001U		7	0.0067 U	0.097	5
Fluoranthene	0.0001U		0.00011		7	0.02	1.2	5
Fluorene	0.0001U		0.0002		7	0.0067 U	0.067 U	5
Indeno(1,2,3-cd)pyrene	0.0001U		0.0002U		7	0.02	0.72	5
Naphthalene	0.0001U		0.005U		7	0.0067 U	0.067 U	5
Phenanthrene	0.0001U		0.005U		7	0.0067 U	0.4	5
Pyrene	0.0001U		0.0002		7	0.021	1.3	5
PCBs								
Total PCBs	ND		ND		7	ND	0.23	5
Conventional Compounds								
TOC						1200	29000	5

^a Sources: Removal Site Assessment Report, Volume I, Technical Report, and Volume 2, Technical Appendixes (CH2M HILL, January 1995), Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary (CH2M HILL, May 10, 1995); and Technical Memorandum DS No. 14: Data Summary for the South Wetlands Addendum to the RI/FS Work Plan, Part 1--Soil, Surface Water, and Groundwater Quality (CH2M HILL, February 12, 1997).

^b Sources: Removal Site Assessment Report, Volume I, Technical Report, and Volume 2, Technical Appendixes, and Technical Memorandum DS No. 1: West Drainage Area Sampling Program Data Summary.

ND = All aroclors were not detected.

U = undetected.

Table 5-8
Summary of Investigations at East Lake

Investigation	Purpose	Description	Key Findings	Reference
Removal Site Assessment (1994)	Evaluate nature and extent in East Lake	One surface water and one sediment sample were collected in East Lake, midlake.	Surface Water: No cyanide (CN), polynuclear aromatic hydrocarbons (PAHs), or polycyclic biphenyls (PCBs) were detected. Fluoride (F) and one total petroleum hydrocarbon (TPH) were detected. Sediment: No CN, F, PCBs, or TPH were detected. PAHs were detected	<i>Removal Site Assessment Report, Volume 1, Technical Report, and Volume 2, Technical Appendixes</i> (CH2M HILL, January 1995)
Water Elevation Data Collection (1997)	Determine groundwater/surface water interactions in East Lake	Average GW elevation was interpolated from individual monitoring wells located north of dike to provide estimated GW elevation for East Lake area.	Comparison of average GW elevations with the bottom of East Lake indicates the average GW elevations were below the lake bottom for February, August, and November 1997. Only during flood events does GW levels rise above lake bottom elevation.	<i>Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan</i> (CH2M HILL, April 3, 1998)
Geoprobe Investigation (1997)	Monitor fluoride in groundwater (GW) in vicinity of East Lake	Two Geoprobe locations (GP18 and GP11) were installed in vicinity of East Lake.	Fluoride was detected in both Geoprobes. Concentration of 2.5 mg/L at GP18 at the southwest corner of the lake and 4.36 mg/L at GP11 east of East Lake on the shore of the Sandy River. Based on results of Geoprobes, MW 53-034 was installed and sampled. No CN, PAHs, or volatile organic compounds (VOCs) were detected. Fluoride and 8 total metals were detected in GW.	<i>Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan</i> (CH2M HILL, April 3, 1998)
Supplemental Data Collection (1998)	Evaluate nature and extent	Two surface water and two sediment samples were collected in East Lake.	Surface Water: No CN, PAHs, PCBs, or TPHs. Only dissolved manganese (Mn) was detected. Sediment: No CN, PCBs, or TPHs. PAHs were detected a lower concentrations than 1994.	<i>Draft Surface Water and Sediment Areas Addendum to RI/FS Work Plan</i> (April 3, 1998)

Table 5-9
Summary of Surface Water and Sediment Data at East Lake (1994 and 1998)

	Surface Water ^a (mg/L)				No. of Samples	Sediment ^a (mg/kg)		No. of Samples
	Minimum		Maximum			Minimum	Maximum	
Analyte								
Inorganic Compounds								
Cyanide, Total	0.01U		0.02U		3	0.5 U	1.42 U	3
Fluoride (340.1/.2)						530 J	570 J	2
Fluoride (340.2M)	0.7		0.7		1	5 U	5 U	1
Fluoride (300.0)	0.33R		0.36R		2	1 U	77	2
Fluoride (GI Extraction)						75 U	75 U	2
Metals	Dissolved	Total	Dissolved	Total		Total	Total	
Aluminum	0.05 U	0.0906	0.05 U	0.221	2,3	13700	34100	3
Arsenic	0.004 U	0.004 U	0.005 U	0.004 U	2,3	3.2	5.4 U	3
Barium	0.02 U	0.02 U	0.02 U	0.02 U	2,3	79.4	156	3
Copper	0.002 U	0.0021	0.002 U	0.0051	2,3	31.6	58.8	3
Iron	0.1 U	0.774	0.1 U	0.89	2,3	18700	24000	3
Lead	0.001 U	0.001 U	0.001 U	0.0044	2,3	14 J	28	3
Magnesium	2.03	1.9	2.05	2.41	2,3	3400	6960	3
Manganese	0.0498	0.073	0.05 U	0.085	2,3	220	447	3
Nickel	0.04 U	0.04 U	0.04 U	0.04 U	2,3	26.3	45	3
Vanadium	0.02 U	0.02 U	0.02 U	0.02 U	2,3	48.9	111	3
Zinc	0.05 U	0.05 U	0.05 U	0.05 U	2,3	78.5	135	3
PAHs								
Acenaphthene	0.0001U		0.0001U		3	0.042 U	0.17 U	3
Acenaphthylene	0.0001U		0.0001U		3	0.042 U	0.17 U	3
Anthracene	0.0001U		0.0001U		3	0.042 U	0.17 U	3
Benzo(a)anthracene	0.0001U		0.0001U		3	0.191	0.72	3
Benzo(a)pyrene	0.0001U		0.0001U		3	0.222	0.9	3
Benzo(b)fluoranthene	0.0001U		0.0001U		3	0.239	1.4	3
Benzo(g,h,i)perylene	0.0001U		0.0001U		3	0.182	0.76	3
Benzo(k)fluoranthene	0.0001U		0.0001U		3	0.152	0.336 D	3
Chrysene	0.0001U		0.0001U		3	0.259	1	3
Dibenzo(a,h)anthracene	0.0001U		0.0001U		3	0.044	0.101	3
Fluoranthene	0.0001U		0.0001U		3	0.243	0.96	3
Fluorene	0.0001U		0.0001U		3	0.042 U	0.17 U	3
Indeno(1,2,3-cd)pyrene	0.0001U		0.0001U		3	0.2	0.69	3
Naphthalene	0.0001U		0.0001U		3	0.042 U	0.17 U	3
Phenanthrene	0.0001U		0.0001U		3	0.17 U	0.333	3
Pyrene	0.0001U		0.0001U		3	0.236	1	3
PCBs								
Total PCBs	ND		ND		3	ND	ND	3
Conventional Compounds								
TOC						16500	38000	3

^a Sources: Removal Site Assessment Report, Volume I, Technical Report, and Volume 2, Technical Appendixes (CH2M HILL, January 1995), and the Draft Surface Water and Sediment Areas Addendum to the RI/FS Work Plan (CH2M HILL, April 13, 1998).

R = Result is rejected due to gross QA/QC outliers; presence or absence of material cannot be certain.

U = undetected.

ND = All aroclors were not detected.

Total petroleum hydrocarbon (TPH) was detected at 5.1 mg/L in one surface water sample collected in 1994.

GI extraction = Extraction procedure agreed to by the agencies that simulates the digestive tract to determine what fraction of fluoride might be bioavailable.

Figures

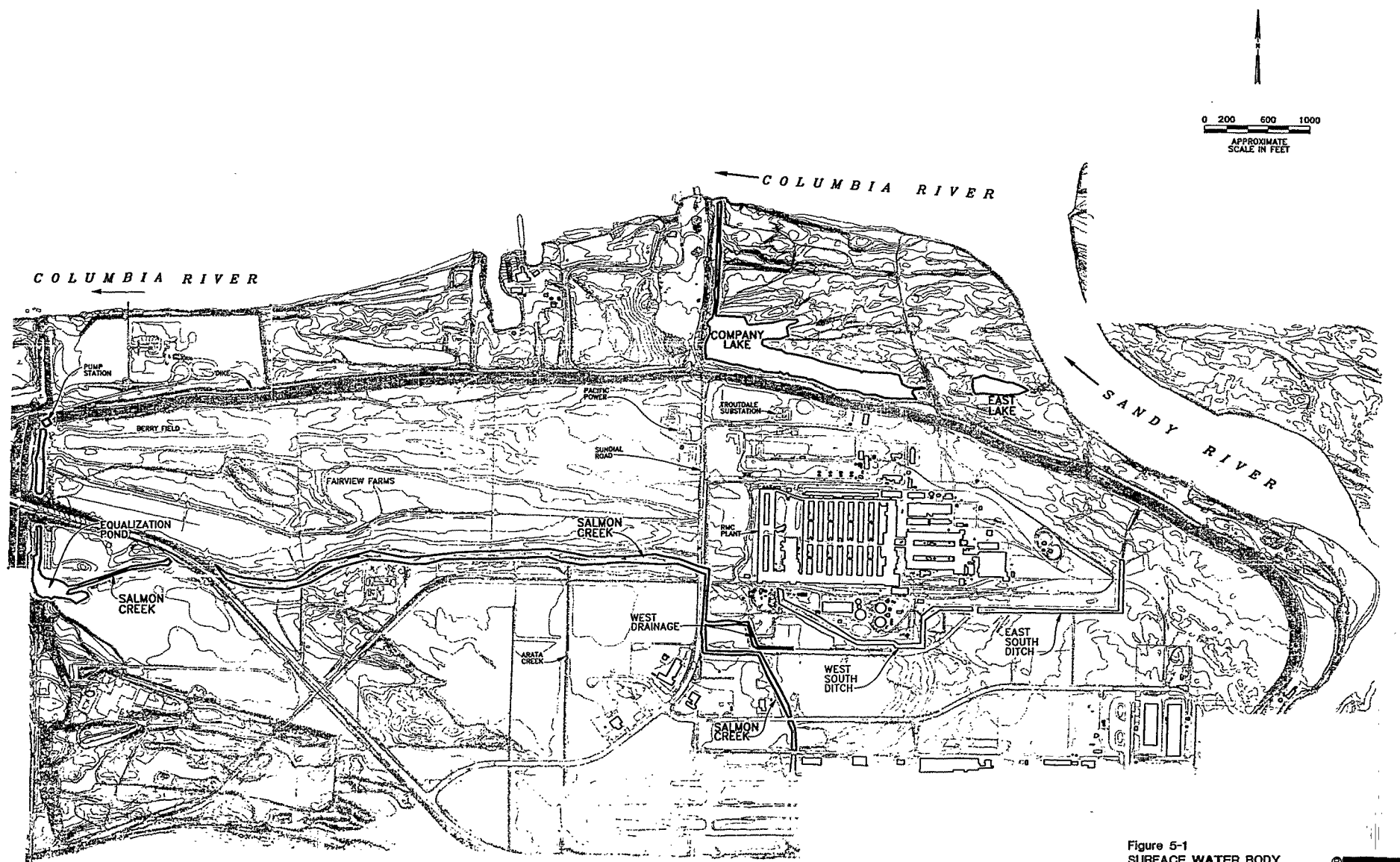


Figure 5-1
 SURFACE WATER BODY
 LOCATION MAP
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report



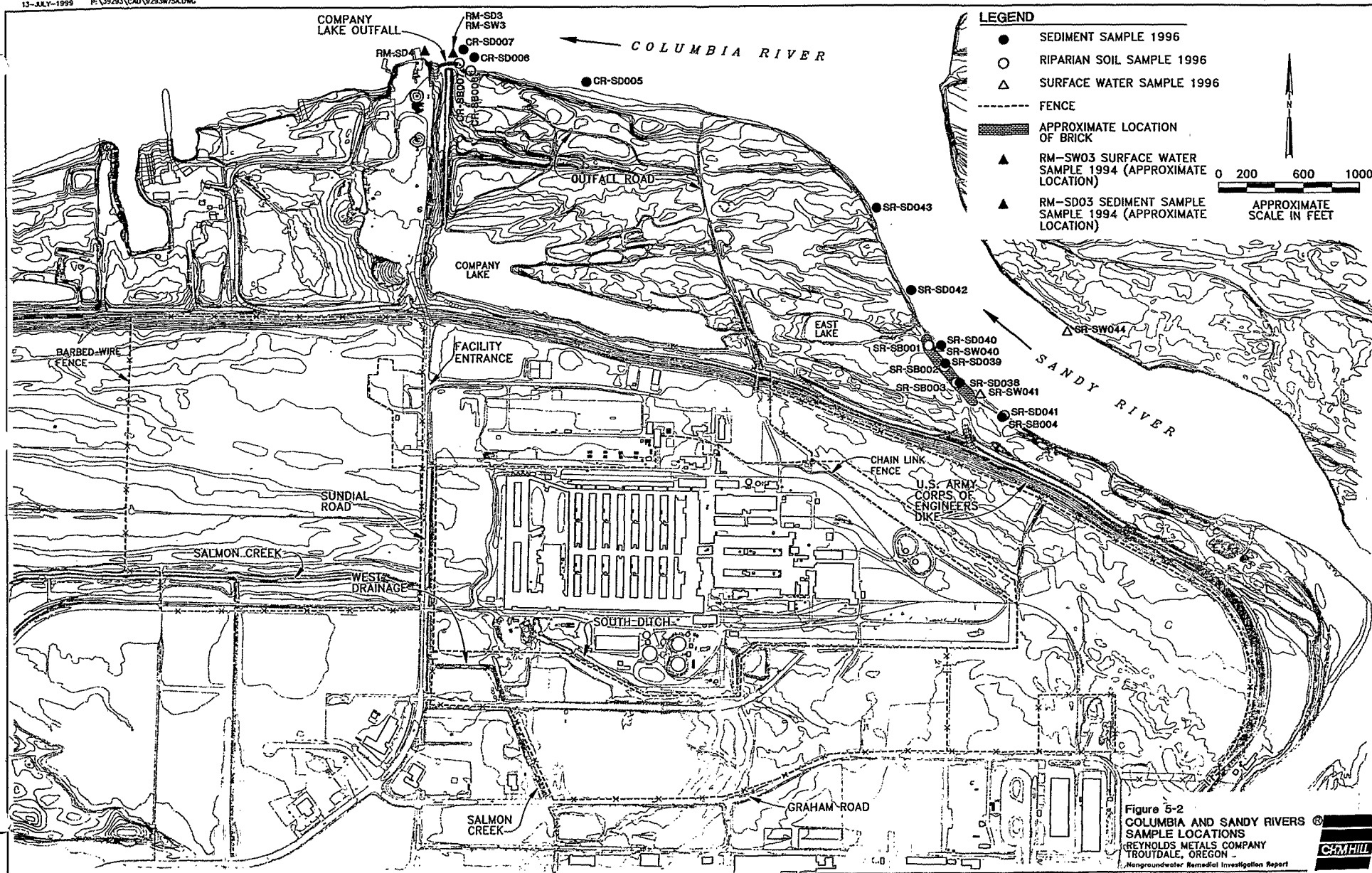


Figure 5-2
COLUMBIA AND SANDY RIVERS
SAMPLE LOCATIONS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial Investigation Report



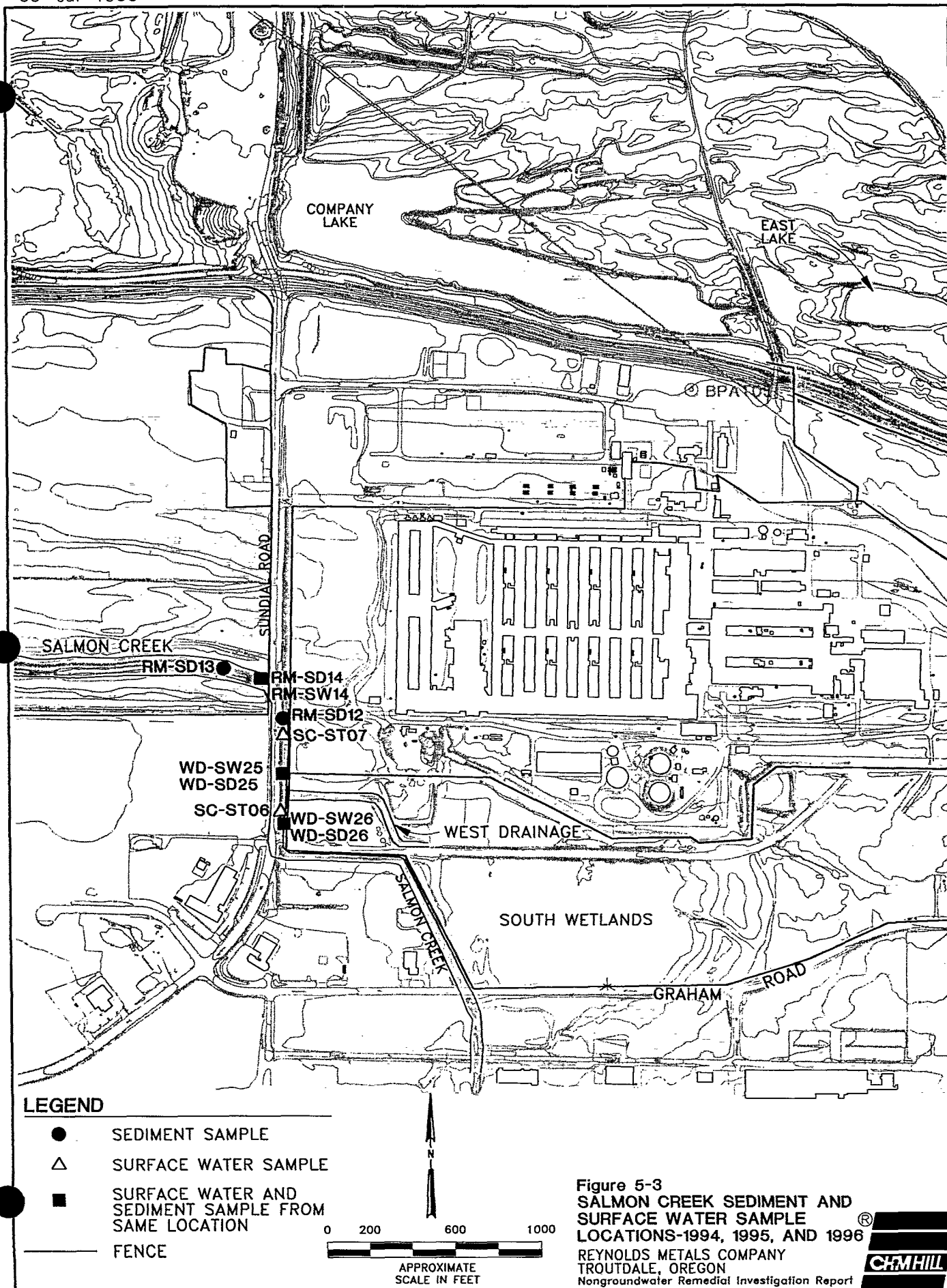


Figure 5-3
**SALMON CREEK SEDIMENT AND
 SURFACE WATER SAMPLE
 LOCATIONS-1994, 1995, AND 1996**
 REYNOLDS METALS COMPANY
 TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report



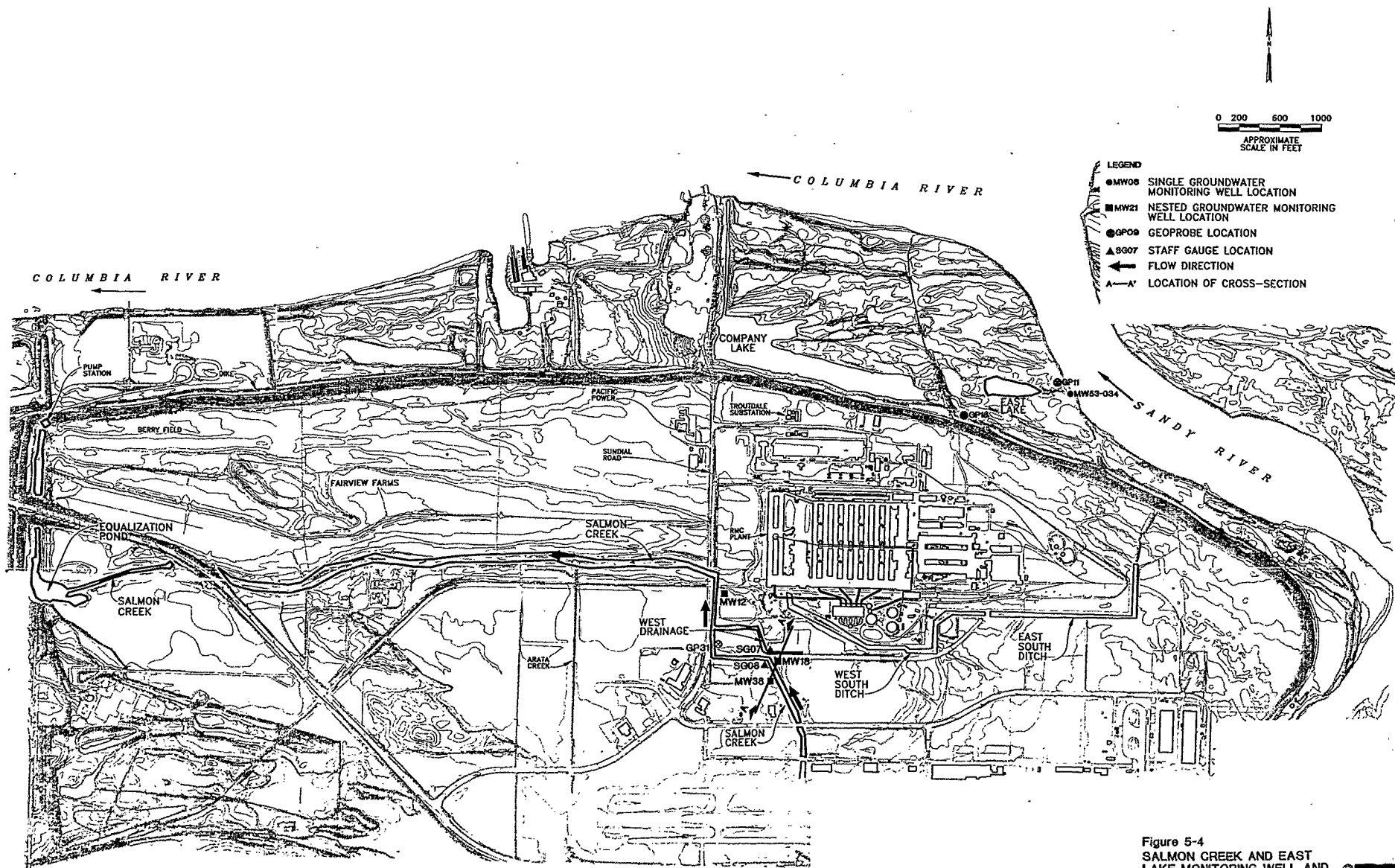


Figure 5-4
SALMON CREEK AND EAST
LAKE MONITORING WELL AND
GEOPROBE LOCATION MAP
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Nongroundwater Remedial Investigation Report

SECTION 6

References

SECTION 6

References

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APPENDIX

Background Data Summary for Nongroundwater Media

APPENDIX

Background Data Summary for Nongroundwater Media

Introduction

Background data are summarized in this appendix for the following environmental media:

- Soil (upland and wetland)
- Sediment (Columbia River, Sandy River, and Salmon Creek)
- Surface water (Columbia River, Sandy River, and Salmon Creek)
- Fish tissue (Columbia River)

Background data were also collected for groundwater and are presented in Appendix B of the *Draft Baseline Risk Assessment, Part 2—Groundwater* (CH2M HILL, July 1999).

Available data were compiled for inorganic constituents (cyanide, fluoride, and metals), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH).

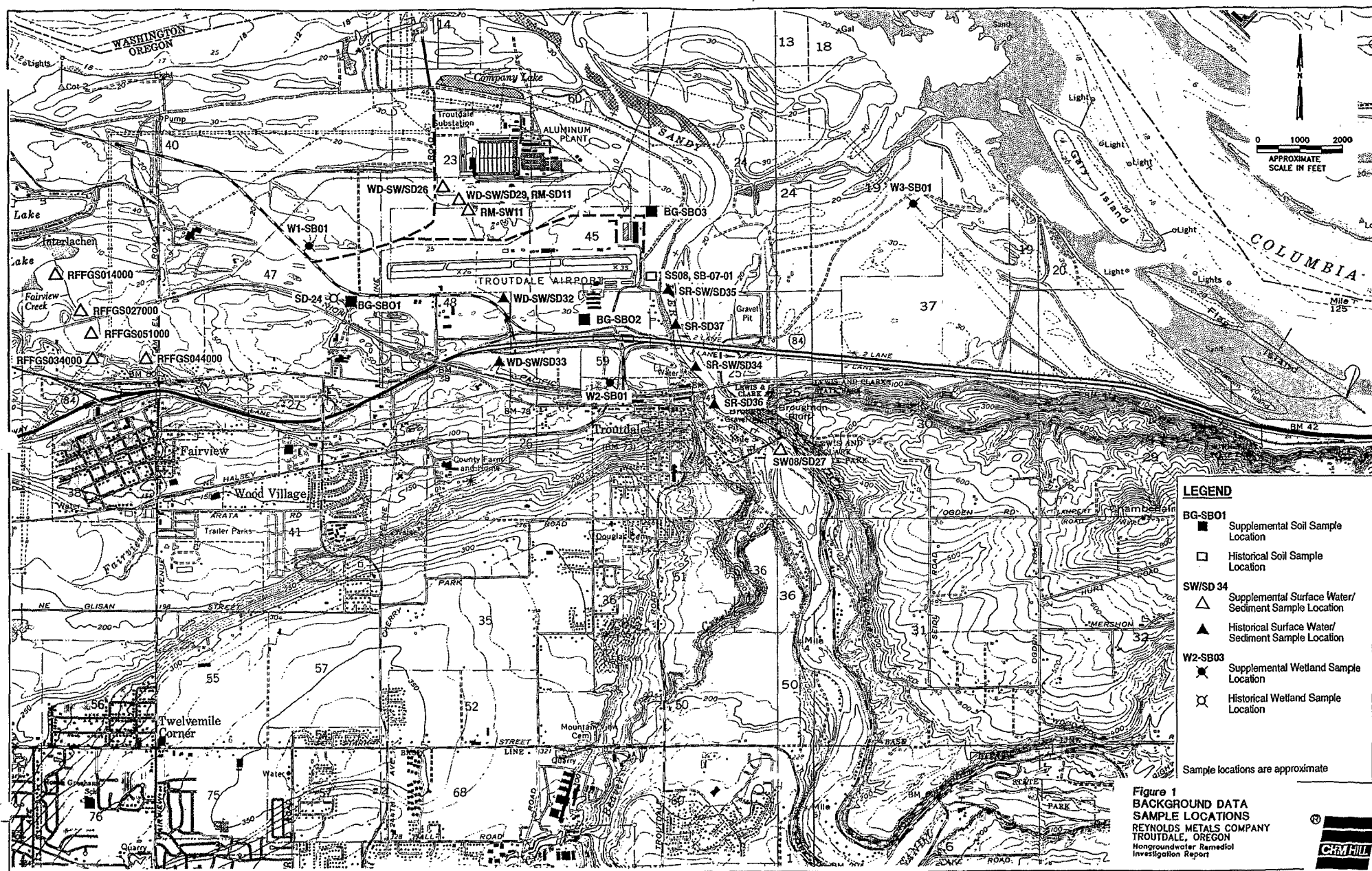
Background sample locations for upland and wetland soils, surface water, and sediment in the Sandy River and Salmon Creek are shown in Figure 1. Columbia River surface water, sediment, and fish sample locations are shown in Figure 2.

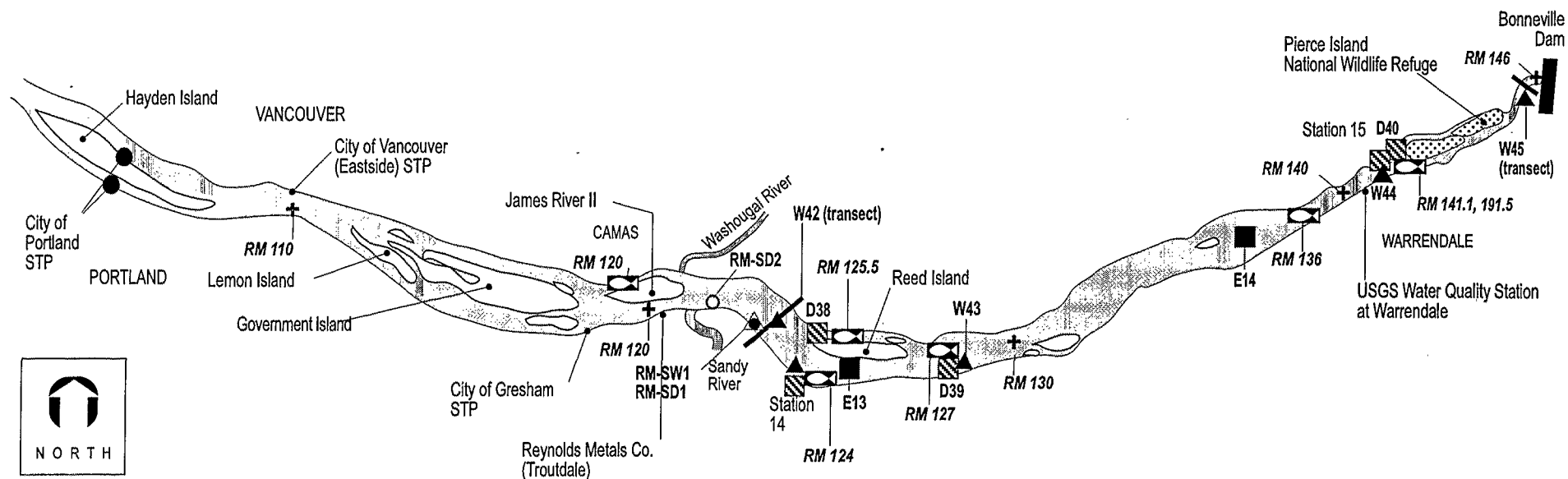
The information in this appendix was originally submitted to the U.S. Environmental Protection Agency (EPA) as *Technical Memorandum DS No. 12: Background Data Summary for RMC-Troutdale* (CH2M HILL, December 3, 1996).

Data Sources

Available background data were reviewed to determine applicability for use in establishing background conditions for the Reynolds Metals Company (RMC) facility. In addition, CH2M HILL team members collected supplemental background data in summer 1996 to augment the existing data. Background data, described briefly below, were compiled from the following five sources:

- Supplemental background data
- Historical CH2M HILL data
- PRC Environmental, Inc., data
- Fairview Creek data
- Columbia River data





LEGEND

- River mile
- Wildlife refuge
- D/E Depositional locations sampled for sediment*
- D/E Nondepositional locations sampled for sediment*
- Tetra Tech surface water sample location
- CH2M HILL sediment sample location
- CH2M HILL surface water and sediment sample location
- Tetra Tech fish sampling area

* Sampling locations were labeled before actual field work as D or E depending on whether they were expected to be depositional or nondepositional, respectively. Sediment grain-size analysis conducted after sample collection, however, resulted in some D locations being reclassified as nondepositional, and some E locations being reclassified as depositional.

Source: Tetra Tech, 1993 (Figure 1-4)

Figure 2
COLUMBIA RIVER SURFACE WATER,
SEDIMENT, AND FISH SAMPLE LOCATIONS
 REYNOLDS METALS COMPANY, TROUTDALE, OREGON
 Nongroundwater Remedial Investigation Report

Supplemental Background Data

Supplemental background data were collected from June 24 to July 2, 1996, in accordance with the *Sampling Plan for Gathering Background Data* (CH2M HILL, May 9, 1996), with the exception explained in the next paragraph. The data results from the sampling event are reported for the first time in this technical memorandum. Samples were collected for upland and wetland soils and for surface water and sediment in the Sandy River and Salmon Creek. Upland and wetland soils were analyzed independently to evaluate whether these soil types represented different levels of naturally occurring constituents.

One change from the sampling plan is noteworthy: two additional sediment samples were collected in the Sandy River. Field reconnaissance indicated several potential sources upstream of the RMC facility (for example, Beaver Creek and the Troutdale Wastewater Treatment Plant) that may affect sediment quality. Additional sediment samples were collected downstream of these potential sources to evaluate the variability in sediment quality.

Historical CH2M HILL Data

CH2M HILL team members collected background surface water and sediment samples in Salmon Creek, upstream of the West Drainage confluence and near Graham Road, in August 1994 and February 1995. They also collected background surface water and sediment samples in the Columbia River, upstream of the Sandy River confluence, in August 1994. The data referenced in this memorandum are reported in the *Draft Current Situation Summary* (CH2M HILL, April 1996).

PRC Data

In 1993, PRC Environmental, Inc., collected background data for upland and wetland soils, and for surface water and sediment in the Sandy River. Data are reported in the *Final Site Inspection Prioritization Report* (PRC Environmental, Inc., October 1993).

Fairview Creek Data

As part of a remedial investigation for sites in the Columbia Slough in Portland, Oregon, background data for sediment were collected in Fairview Creek, near Fairview Lake, in October 1995 (Parametrix, May 1996). Fairview Creek is located in Fairview, Oregon, approximately 1½ miles west of Salmon Creek (see Figure 1). Fairview Creek's land uses and surrounding soil type are similar to those of Salmon Creek. The land uses in both watersheds include undeveloped land, and agriculture, industrial, and residential uses. The soil type for Fairview Creek is Rafton silt loam, while the soil type for Salmon Creek is Faloma silt loam. Both soil types are described as poorly drained soils in the Columbia River floodplain (Green, August 1983). Both silt loams are formed in mixed alluvium, although Rafton silt loam has some volcanic ash mixing as well. Fairview Creek showed ranges of constituents similar to those found in upstream Salmon Creek and is a suitable reference site for background sediment data.

Columbia River Data

Columbia River sediment, surface water, and fish tissue data upstream of the RMC facility have been collected as part of the Lower Columbia River Bi-State Program. Two sources are available for background data:

- *Reconnaissance Survey of the Lower Columbia River* (Tetra Tech, January 1993)
- *Lower Columbia River Backwater Reconnaissance Survey* (Tetra Tech, May 1994)

Background Data Summaries

All analytical data for background soils, sediment, surface water, and fish tissue are provided in the attachment to this Appendix. The following sections provide a brief summary (including summary statistics) of each environmental medium.

Soil

Background soil data have been classified as upland or wetland. A brief summary of the available data is provided below. Background soil concentrations are provided on a dry-weight basis.

Upland Soil

Six background samples were collected by CH2M HILL as part of the supplementary background data gathering in summer 1996, and one sample was collected by PRC in 1993. A summary of the inorganic constituents is provided in Table 1.

Table 1
Summary of Background Data for Upland Surface Soil

Analyte (mg/kg)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	7	0			1	2.6		
Fluoride (340.1/.2)	6	6	180	240			208	20
Fluoride (340.2)	6	3	2.6	3.7	2.5	2.5	3.3	0.6
Total Organic Carbon	6	6	7950	58100			25247	22354
Aluminum	7	7	7270	10500			8561	1346
Antimony	7	0			2.5	5.9		
Arsenic	7	7	0.984	1.6			1.3	0.2
Barium	7	7	22.8	63			43	16
Beryllium	7	1	0.48	0.48	0.5	0.5	0.48	
Cadmium	7	0			0.41	0.5		
Calcium	7	7	2200	2860			2461	258
Chromium	7	7	7.7	11.5			9.6	1.4
Cobalt	7	7	2.61	5.1			3.5	0.8
Copper	7	7	9.32	18.9			13.7	3.6
Iron	7	7	8160	11800			10354	1217
Lead	7	7	5.4	25.9			13.3	8.1
Magnesium	7	7	791	1590			1227	314
Manganese	7	7	68.5	192			125	38
Mercury	7	1	0.08	0.08	0.2	0.2	0.08	
Nickel	7	7	5.9	9.6			8.1	1.4
Potassium	7	6	240	422	263	263	320	73
Selenium	7	0			0.32	1		
Silver	7	0			0.33	1		
Sodium	7	7	363	670			471	131
Thallium	7	0			0.41	1		
Vanadium	7	7	32.1	58.1			40.0	9.1
Zinc	7	7	19.2	102			44.7	29.5

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PAHs were detected in the seven samples analyzed, and no PCBs were detected in the one sample analyzed. All upland soil data are provided in the Attachment (Table A1).

Wetland Soil

Six samples were collected by CH2M HILL as part of the supplementary background data-gathering effort in summer 1996, and one sample was collected by PRC in 1993. A summary of the inorganic constituents is provided in Table 2.

Table 2
Summary of Background Data for Wetland Soil

Analyte	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	7	0			1	3		
Total Fluoride (340.1 / .2)	6	6	120	250			178	51
Total Organic Carbon	7	7	17400	26100			21367	3301
Aluminum	7	7	4720	14600			9653	3660
Antimony	7	1	2.5	2.5	2.5	6.7	2.5	
Arsenic	7	7	0.84	11.9			4.69	4.01
Barium	7	7	33.8	107			75	32
Beryllium	7	4	0.51	0.72	0.50	0.50	0.60	0.10
Cadmium	7	2	0.64	0.77	0.47	0.50	0.71	0.09
Chromium	7	7	8.65	19.3			14.01	4.80
Cobalt	7	4	3.26	7.21	2.5	2.5	5.21	1.80
Copper	7	7	7.9	28.5			21.7	7.1
Iron	7	7	6190	122000			36849	43639
Lead	7	7	0.71	28			15.2	9.6
Magnesium	7	7	924	3950			2172	1225
Manganese	7	7	63.7	252			128	70
Mercury	7	0			0.09	0.20		
Nickel	7	7	5.25	15.5			11.1	4.6
Potassium	7	7	266	1900			768	702
Selenium	7	1	0.35	0.35	1	1	0.35	
Silver	7	0			0.37	1		
Sodium	7	7	262	647			419	148
Thallium	7	0			0.18	1		
Vanadium	7	7	33	125			64	40
Zinc	7	7	26.6	140			70	47

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PAHs were detected in the seven samples collected, and no PCBs were detected in the one sample collected. All wetland soil data are provided in the Attachment (Table A2).

Sediment

A brief summary of the available sediment data for the Columbia River, Sandy River, and Salmon Creek is provided below. Background sediment concentrations are provided on a dry-weight basis.

Columbia River Sediment

Two sediment samples were collected in the Columbia River by CH2M HILL in 1994 and seven samples were collected by Tetra Tech in 1991 and 1993. A summary of the inorganic constituents is provided in Table 3.

Table 3
Summary of Background Data for Columbia River Sediment

Analyte (mg/kg)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	4	0			0.1	1		
Fluoride (340.2M)	2	0			5	5		
Total Organic Carbon	9	9	400	37000			6500	11809
Aluminum	9	9	5000	16300			8815	4511
Antimony	9	0			0.25	5.19		
Arsenic	9	9	1.51	4.4			3.00	0.96
Barium	9	9	60.8	164.5			109.28	37.07
Beryllium	9	2	0.62	0.68	0.50	3.31	0.65	0.04
Cadmium	9	7	0.13	1.9	0.50	1	0.62	0.63
Calcium	2	2	2400	3600			3000	849
Chromium	9	9	5.47	18.9			10.59	5.09
Cobalt	2	2	11	12			11.50	0.71
Copper	9	9	2.39	24.8			10.29	7.82
Iron	9	9	10243	18900			15519	3122
Lead	9	8	4.83	17.6	10	10	10.1	5.1
Magnesium	2	2	2700	3500			3100	566
Manganese	2	2	270	270			270	
Mercury	9	2	0.07	0.08	0.058	0.20	0.08	0.01
Nickel	9	9	9.28	18			13.5	2.6
Potassium	2	2	440	770			605	233
Selenium	9	0			0.29	1.2		
Silver	9	0			0.10	1		
Sodium	2	2	200	220			210	14
Thallium	9	0			0.34	12.45		
Vanadium	2	2	45	46			46	0.7
Zinc	9	9	44.1	155			89	35

¹ Arithmetic average and standard deviation shown for detected concentrations only.

PAHs were detected in three of the nine samples analyzed; because detection limits were higher in some of the samples, it is possible that some of the remaining six samples had similar PAH concentrations. Detected PAHs ranged from 0.1 to 1.0 milligrams per kilogram (mg/kg). No PCBs were detected in the eleven samples collected. All Columbia River sediment data are provided in the Attachment (Table A3).

Sandy River Sediment

Four Sandy River sediment samples were collected by CH2M HILL during summer 1996, and one sample was collected by PRC in 1993. A summary of the inorganic constituents is provided in Table 4.

Table 4
Summary of Background Data for Sandy River Sediment

Analyte (mg/kg)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	5	0			1	3.3		
Fluoride (340.1/.2)	5	5	119	160			134	17
Fluoride (340.2M)	4	0			2.5	2.5		
Total Organic Carbon	4	4	669	2650			1367	916
Aluminum	5	5	3890	8390			6038	1615
Antimony	5	0			2.5	7.2		
Arsenic	5	4	0.51	1.8	0.42	0.42	0.99	0.56
Barium	5	5	8	32.9			19.6	9.3
Beryllium	5	1	0.61	0.61	0.50	0.50	0.61	
Cadmium	5	0			0.50	0.50		
Calcium	5	5	2800	3450			3056	291
Chromium	5	5	7.76	14.7			11.3	2.6
Cobalt	5	5	3.22	7.5			4.7	1.7
Copper	5	5	10.4	15.2			11.9	2.0
Iron	5	5	8810	13100			11002	1570
Lead	5	1	0.26	0.26	5	5	0.26	
Magnesium	5	5	1370	1810			1616	200
Manganese	5	5	103	156			128	23
Mercury	5	0			0.10	0.20		
Nickel	5	5	7.13	11.2			9.3	1.5
Potassium	5	4	190	247	67	67	228	26
Selenium	4	0			1	1		
Silver	5	0			0.40	1		
Sodium	5	5	504	918			656	166
Thallium	5	0			0.21	1		
Vanadium	5	5	31.4	46.8			40.0	6.0
Zinc	5	5	17.1	38.4			27.6	8.6

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PAHs were detected in the five samples collected, and no PCBs were detected in the four samples where they were analyzed. All Sandy River sediment data are provided in the Attachment (Table A4).

Salmon Creek/Fairview Creek Sediment

CH2M HILL collected two sediment samples during summer 1996 and three samples in 1994 to 1995, upstream of the West Drainage confluence with Salmon Creek. Parametrix collected six sediment samples at a nearby reference site (Fairview Creek) in 1995. A summary of the inorganic constituents is provided in Table 5.

Table 5
Summary of Background Data for Salmon Creek Sediment

Analyte (mg/kg)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	11	0			0.022	1		
Fluoride (340.1/.2)	2	2	160	250			205	
Fluoride (340.2M)	1	0			5	5		
Total Organic Carbon	11	11	4400	29000			18209	7888
Aluminum	11	11	7600	25100			15052	5398
Antimony	11	0			0.08	2.5		
Arsenic	11	10	1.7	6.5	1	1	2.99	1.57
Barium	11	11	26	203			95	48
Beryllium	11	6	0.32	0.60	0.20	1	0.43	0.10
Cadmium	11	6	0.20	0.50	0.20	1	0.33	0.10
Calcium	5	5	3200	5200			3904	781
Chromium	11	11	11.7	39.9			22.05	8.61
Cobalt	11	11	4.71	15			9.85	3.15
Copper	11	11	12.1	55			22	12
Iron	11	11	11000	30700			21509	5714
Lead	11	10	10.8	49	10	10	26	11
Magnesium	5	5	1400	3330			2406	757
Manganese	11	11	76	563			265	152
Mercury	11	6	0.03	0.06	0.042	0.20	0.04	0.01
Nickel	11	11	9.62	21			15	4
Potassium	5	5	340	866			606	194
Selenium	11	4	0.18	0.40	0.20	1	0.25	0.10
Silver	11	5	0.03	0.05	0.20	1	0.04	0.01
Sodium	5	5	374	710			571	143
Thallium	11	0			0.09	1		
Vanadium	11	11	41.4	83			62	13
Zinc	11	11	62.3	200			118	46

¹ Arithmetic average and standard deviation shown for detected concentrations only.

Low-level PAHs were detected in sediments for nine of the eleven sediment samples; the two remaining samples showed no detected concentrations, but detection limits were higher for these two samples. Total PAHs ranged from below detectable levels to 5.1 mg/kg in upstream Salmon Creek and from 0.1 to 0.6 mg/kg in Fairview Creek.

PCBs were undetected in the eleven samples except for one sample in Salmon Creek, where only Aroclor 1254 was detected, at 0.12 mg/kg. TPH was also detected in two out of the three upstream Salmon Creek samples. All data are provided in the Attachment (Table A5).

Surface Water

A brief summary of the available surface water data for the Columbia River, Sandy River, and Salmon Creek is provided below. All metals data represent total (unfiltered) metals.

Columbia River Surface Water

Two surface water samples were collected in the Columbia River by CH2M HILL in 1994, and seven samples were collected by Tetra Tech in 1991 and 1993. A summary of the inorganic constituents is provided in Table 6.

Table 6
Summary of Background Data for Columbia River Surface Water

Analyte (mg/L)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	7	0			0.002	0.01		
Fluoride	5	0			0.50	0.50		
Hardness	7	7	51.3	62			56.74	3.684
Aluminum	7	4	0.443	1.3	0.10	0.27	0.822	0.444
Antimony	7	0			0.003	0.150		
Arsenic	7	0			0.003	0.005		
Barium	7	6	0.02	0.032	0.020	0.020	0.025	0.0047
Beryllium	7	0			0.002	0.020		
Cadmium	7	0			0.00004	0.0005		
Calcium	1	1	15	15			15	
Chromium	7	0			0.001	0.02		
Cobalt	1	0			0.05	0.05		
Copper	7	2	0.0026	0.005	0.0031	0.02	0.0038	0.0017
Iron	7	4	0.47	1.80	0.10	0.32	1.06	0.61
Lead	7	2	0.0011	0.0015	0.001	0.004	0.0013	0.0003
Magnesium	1	1	4.7	4.7			4.7	
Manganese	1	0			0.02	0.02		
Mercury	7	0			0.0001	0.0005		
Nickel	7	0			0.005	0.05		
Potassium	1	1	1	1			1	
Selenium	7	0			0.003	0.005		
Silver	7	0			0.001	0.02		
Sodium	1	1	6.2	6.2			6.2000	
Thallium	7	0			0.001	0.36		
Vanadium	1	0			0.02	0.02		
Zinc	7	3	0.005	0.077	0.02	0.05	0.0317	0.039

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PAHs (two samples) were detected, no PCBs (two samples) were detected, and no TPH was detected (one sample). All Columbia River surface water data are provided in the Attachment (Table A6).

Sandy River Surface Water

Two surface water samples were collected in the Sandy River by CH2M HILL in summer 1996, and one sample was collected by PRC in 1993. A summary of the inorganic constituents is provided in Table 7.

Table 7
Summary of Background Data for Sandy River Surface Water

Analyte (mg/L)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide	3	0			0.01	0.02		
Fluoride	3	0			0.10	0.25		
Hardness	2	2	18.7	18.7			18.7	
Aluminum	3	3	0.0895	0.15			0.12	0.03
Antimony	3	0			0.005	0.0287		
Arsenic	3	0			0.0011	0.004		
Barium	3	0			0.0051	0.02		
Beryllium	3	0			0.0003	0.0018		
Cadmium	3	0			0.002	0.002		
Chromium	3	0			0.005	0.010		
Cobalt	3	0			0.0104	0.050		
Copper	3	0			0.002	0.0022		
Iron	3	2	0.16	0.157	0.136	0.136	0.157	0.0007
Lead	3	1	0.0011	0.0011	0.001	0.001	0.0011	
Magnesium	3	3	1.18	1.73			1.55	0.32
Manganese	3	1	0.00	0.0047	0.02	0.02	0.0047	
Mercury	3	0			0.0002	0.0002		
Nickel	3	0			0.0153	0.04		
Potassium	3	0			0.537	1		
Selenium	3	1	0.00	.0016	0.005	0.005	0.002	
Silver	3	0			0.0016	0.003		
Sodium	3	3	2.46	3.91			3.36	0.78
Thallium	3	0			0.0008	0.002		
Vanadium	3	0			0.0047	0.02		
Zinc	3	0			0.05	0.0524		

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PAHs (three samples) were detected and no PCBs (three samples) were detected. All Sandy River surface water data are provided in the Attachment (Table A7).

Salmon Creek Surface Water

CH2M HILL collected two surface water samples (in summer 1996) and three samples (in 1994-95) in Salmon Creek. A summary of the inorganic constituents is provided in Table 8.

Table 8
Summary of Background Data for Salmon Creek Surface Water

Analyte (mg/L)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Total Cyanide					0.01	0.02		
Fluoride	5	0			0.25	0.50		
Hardness	3	3	57	63			61	3.4
Aluminum	5	2	0.10	0.14	0.05	0.10	0.12	0.03
Antimony	5	0			0.01	0.01		
Arsenic	5	0			0.004	0.004		
Barium	5	0			0.02	0.02		
Beryllium	5	0			0.0003	0.02		
Cadmium	5	0			0.0003	0.002		
Calcium	5	5	13	15.3			14.7	1.0
Chromium	5	0			0.01	0.02		
Cobalt	5	0			0.05	0.05		
Copper	5	0			0.002	0.02		
Iron	5	5	0.169	0.63			0.36	0.23
Lead	5	0			0.001	0.004		
Magnesium	5	5	5.6	6.2			6.0	0.2
Manganese	5	4	0.027	0.058	0.02	0.02	0.04	0.01
Mercury	5	0			0.0002	0.001		
Nickel	5	0			0.04	0.05		
Potassium	5	5	2.3	3.1			2.8	0.3
Selenium	5	0			0.004	0.01		
Silver	5	0			0.003	0.02		
Sodium	5	5	5.8	7.6			6.9	0.7
Thallium	5	0			0.002	0.004		
Vanadium	5	0			0.02	0.02		
Zinc	5	0			0.05	0.05		

¹ Arithmetic average and standard deviation shown for detected concentrations only.

No PCBs (five samples) were detected in surface water. PAHs (five samples) were undetected in four samples, but one sample showed low concentrations of benzo(b)fluoranthene and fluoranthene [both at 0.00011 milligrams per liter (mg/L)] and pyrene (at 0.00013 mg/L). Diesel-related TPH was detected in one of the three surface water samples at 0.28 mg/L. All Salmon Creek surface water data are provided in the Attachment (Table A8).

Fish Tissue

Fish from the Columbia River were collected under the Lower Columbia River Bi-State Program (Tetra Tech, January 1993 and May 1994) to determine concentrations in tissues. Eleven composite tissue samples were analyzed for metals, PAHs, and PCBs in large-scale sucker and carp whole body samples, and in white sturgeon filet samples. A summary of the inorganic constituents is provided in Table 9.

Table 9
Summary of Background Data for Fish Tissue

Analyte (mg/L)	No. of Samples	No. of Detects	Minimum Detect	Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	Average ¹	Standard Deviation ¹
Antimony	11	0			0.011	2.4		
Arsenic	11	2	0.27	0.84	0.034	0.58	0.56	0.40
Barium	11	9	1.2	3.7	0.1	0.1	2.9	1.0
Cadmium	11	9	0.039	0.29	0.02	0.02	0.09	1.73
Chromium	5	5	0.078	0.527			0.34	0.17
Copper	11	10	0.5	1.68	0.48	0.48	1.12	0.36
Lead	11	10	0.02	0.41	0.009	0.009	0.21	0.13
Mercury	11	10	0.051	0.215	0.001	0.001	0.12	0.05
Nickel	11	5	0.13	17.29	0.1	1.02	4.11	7.42
Selenium	11	0			0.034	0.58		
Silver	11	1	0.005	0.005	0.004	0.26	0.005	
Zinc	11	11	3.8	109.6			38.8	38.5

¹ Arithmetic average and standard deviation shown for detected concentrations only.

PAHs were not detected in fish tissue except for one low-level detection of naphthalene in whole-body large-scale sucker. PCBs (Aroclors 1232, 1254, and 1260) were detected in many of the fish samples. The fish tissue data, including lipid-normalized concentrations, are provided in the Attachment (Table A9).

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Attachment: Background Data

Table A1: Upland Soils

Table A2: Wetland Soil

Table A3: Columbia River Sediment

Table A4: Sandy River Sediment

Table A5: Salmon Creek Sediment

Table A6: Columbia River Surface Water

Table A7: Sandy River Surface Water

Table A8: Salmon Creek Surface Water

Table A9: Columbia River Fish Tissue

Table A1
Background Data for Upland Soils

Station ID	BG-SB01* Replicate A	BG-SB01* Replicate B	BG-SB02* Replicate A	BG-SB02* Replicate B	BG-SB03* Replicate A	BG-SB03* Replicate B	SS-08 ^b
Location Description	South of Marine Drive, West of Eastwind Road		South of Airport		Northwest of Airport, South of RMC		East of Airport
Date Sampled	6/28/96	6/28/96	6/28/96	6/28/96	6/28/96	6/28/96	5/20/93
Analyte (mg/kg)							
Cyanide, Total	1 U	1 U	1 U	1 U	1 U	1 U	2.6 U
Fluoride (340.1/.2)	240	180	200	200	210	220	
Fluoride (340.2M)	2.5 U	2.5 U	2.6	2.5 U	3.5	3.7	
TOC	58100	49300	7950	8730	14700	12700	
Metals							
Aluminum	8200	9610	7370	7310	9670	10500	7270 J
Antimony	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5.9 U
Arsenic	1.4	1.6	0.984	1.1	1.4	1.1	1.3 B
Barium	57.3	44.4	22.8	23	63	52.5	39 B
Beryllium	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.48 BJ
Cadmium	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.41 U
Calcium	2860	2580	2330	2260	2280	2200	2720 J
Chromium	11.5	11.2	8.97	7.7	8.53	9.15	10.3 J
Cobalt	3.57	2.61	3.57	3.16	3.44	3.38	5.1 B
Copper	16.8	15.5	9.98	9.32	13	12.1	18.9 J
Iron	9620	8160	11800	10300	10700	10400	11500
Lead	21.5	7.7	5.4	5.4	11.2	15.8	25.9
Magnesium	1590	1180	911	791	1510	1500	1110 J
Manganese	138	68.5	119	110	139	106	192 J
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.08 J
Nickel	9.07	7.92	6.74	5.9	8.85	8.8	9.6 J
Potassium	422	303	242	240	340	373	263 BU
Selenium	1 U	1 U	1 U	1 U	1 U	1 U	0.32 UJ
Silver	1 U	1 U	1 U	1 U	1 U	1 U	0.33 U
Sodium	363	372	628	670	368	504	393 B
Thallium	1 U	1 U	1 U	1 U	1 U	1 U	0.41 UJ
Vanadium	44.9	58.1	36.7	32.1	33.3	34.5	40.1
Zinc	60	102	20.6	19.2	31.9	28	51 J
PAHs							
Acenaphthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Acenaphthylene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Benzo(a)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Benzo(a)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Benzo(b)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Benzo(g,h,i)perylene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Benzo(k)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Chrysene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Dibenzo(a,h)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Fluorene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Indeno(1,2,3-cd)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Naphthalene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Phenanthrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
Pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	10 U
PCBs							
Aroclor 1016							0.035 U
Aroclor 1221							0.071 U
Aroclor 1232							0.035 U
Aroclor 1242							0.035 U
Aroclor 1248							0.0044 R
Aroclor 1254							0.035 U
Aroclor 1260							0.035 U

U = Substance was not detected. Value given is lower quantification limit.

J = Estimated value.

R = Rejected data.

B = Below reporting limit and above instrument detection limit.

a = Source: Supplemental Background Data-Gathering

b = Source: Final Site Inspection Report (PRC, October 1993)

Table A2
Background Data for Wetland Soil

Station ID	W1-SB01 ^a Replicate A	W1-SB01 ^a Replicate B	W2-SB01 ^a Replicate A	W2-SB01 ^a Replicate B	W3-SB01 ^a Replicate A	W3-SB01 ^a Replicate B	SD-24 ^b
Location Description	At Intersection of Marine Drive and Sundial Road		West of Graham Road and South of I-84		East of Sandy River, North of I- 84		South of Marine Drive, near Sundial Road
Date Sampled	6/28/96	6/28/96	6/28/96	6/28/96	6/28/96	6/28/96	5/20/93
Analyte (mg/kg)							
Cyanide, Total	1 U	1 U	1 U	1 U	1 U	1 U	3 U
Fluoride (340.1/.2)	170	120	140	160	250	230	
Fluoride (340.2M)	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	
TOC	22400	22500	22100	26100	17700	17400	
Metals							
Aluminum	11100	11500	6320	6930	12400	14600	4720 J
Antimony	2.5 U	2.5 U	2.5 U	2.5 U	2.5 J	2.5 U	6.7 UJ
Arsenic	11.9	6.76	1.1	1.4	5.97	4.87	0.84 BJ
Barium	94.2	96.6	33.8	52.8	104	107	37.7 B
Beryllium	0.72	0.63	0.5 U	0.5 U	0.5 U	0.51	0.53 B
Cadmium	0.5 U	0.5 U	0.5 U	0.5 U	0.77	0.64	0.47 U
Calcium	2910	2160	2780	3360	3610	3740	2680 J
Chromium	17.2	18	8.65	8.91	16.7	19.3	9.3
Cobalt	2.5 U	3.26	2.5 U	2.5 U	7.21	6.17	4.2 B
Copper	26.4	25.8	18.7	19.6	25.3	28.5	7.9 J
Iron	122000 D	70400	6190	6550	21500	21000	10300 J
Lead	18.3	21.2	6.3	11.1	21.1	28	0.71 J
Magnesium	1960	1560	924	1130	3810	3950	1870 J
Manganese	123	91.6	63.7	69.5	252	192	102 J
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.09 UJ
Nickel	15.1	13.7	5.25	5.81	14.4	15.5	7.6 B
Potassium	400	495	266	298	1670	1900	344 B
Selenium	1 U	1 U	1 U	1 U	1 U	1 U	0.35 R
Silver	1 U	1 U	1 U	1 U	1 U	1 U	0.37 U
Sodium	262	272	581	647	351	439	382 BJ
Thallium	1 U	1 U	1 U	1 U	1 U	1 U	0.18 U
Vanadium	125	118	33	37.8	47.9	51.6	34 J
Zinc	60.3	59.7	26.6	32.5	130	140	37.5 J
PAHs							
Acenaphthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Acenaphthylene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Benzo(a)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.027 J
Benzo(a)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Benzo(b)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Benzo(g,h,i)perylene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Benzo(k)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.036 J
Chrysene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.035 J
Dibenzof(a,h)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.031 J
Fluorene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Indeno(1,2,3-cd)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Naphthalene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Phenanthrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.39 U
Pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.041 J
PCBs							
Aroclor 1016							0.039 U
Aroclor 1221							0.079 U
Aroclor 1232							0.039 U
Aroclor 1242							0.039 U
Aroclor 1248							0.039 U
Aroclor 1254							0.039 U
Aroclor 1260							0.039 U

U = Substance was not detected. Value given is lower quantification limit.

J = Estimated value.

R = Rejected data.

B = Below reporting limit and above instrument detection limit.

D = Compound has been run at a dilution to bring the concentration of that compound within the linear range of the instrument

a = Source: Supplemental Background Data Gathering

b = Source: Final Site Inspection Report (PRC, October 1993)

Table A3
Background Data for Columbia River Sediment

Station ID	RM-SD2 ^c	RM-SD1 ^c	Station 14 ^b	D38 ^a	E13 ^a	D39 ^a	E14 ^a	D40 ^a	Station 15 ^b
River Mile	RM 121	RM 123	RM 124	RM 125	RM 125.5	RM 128	RM 137	RM 141	RM 141
Date Sampled	8/18/94	8/18/94	7/1/93	9/25/91	9/25/91	9/24/91	9/24/91	9/24/91	6/30/93
Analyte (mg/kg)									
Cyanide	0.1 U	0.1 U	0.1 U	1 U/R	1 U/R	1 U/R	1 U/R	1 U/R	0.1 U
Fluoride (340.2M)	5 U	5 U							
TOC	3900	1200	37000	700	400	600	800	4500	9400
Total Metals									
Aluminum	6400	5000	16200	5122 E	9032 E	5038 E	6904 E	9336 E	16300
Antimony	1.3 U	2.5 U	0.31 U	4.8 U/E	4.84 U/E	4.72 U/E	4.32 U/E	5.19 U/E	0.25 U
Arsenic	3.3	4	4.4 E	1.92 E	2.9 E	1.51 E	2.36 E	2.87 E	3.7
Barium	97	68	138	60.8 E	164.5 E	69.3 E	132.3 E	117.6 E	136
Beryllium	0.5 U	1 U	0.62	3.14 U/E	3.31 U/E	3.25 U/E	3.18 U/E	3.22 U/E	0.68
Cadmium	0.5 U	1 U	1.9	0.19	0.46	0.13	0.32	0.32	1.0
Calcium	3600	2400							
Chromium	12	10	18.6	6.72 E	5.48 E	8.82 E	5.47 E	9.34 E	18.9
Cobalt	12	11							
Copper	8.9	4.9	24.8	4.16 E	6.13 E	2.39 E	7.48 E	12.79 E	21.1
Iron	18000	16000	18400	10243 E	17742 E	11650 E	13521 E	15214 E	18900
Lead	8.6	10 U	17.6	8.03 E	7.15 E	5.19 E	4.83 E	12.35 E	17.4
Magnesium	3500	2700							
Manganese	270	270							
Mercury	0.2 U	0.2 U	0.08 E	0.064 U/E	0.065 U/E	0.063 U/E	0.058 U/E	0.069 U/E	0.07 E
Nickel	15	18	14.7	9.28 E	14.19 E	10.71 E	12.95 E	12.45 E	14.6
Potassium	770	440							
Selenium	0.5 U	1 U	1.2 U/E	0.32 U/E	0.32 U/E	0.31 U/E	0.29 U/E	0.69 U/E	1.0 U/E
Silver	0.5 U	1 U	0.10 U	0.29 U/E	0.29 U/E	0.28 U/E	0.26 U/E	0.31 U/E	0.11 U
Sodium	200	220							
Thallium	0.5 U	1 U	0.42 U/E	11.52 U/E	11.61 U/E	11.34 U/E	10.36 U/E	12.45 U/E	0.34 U/E
Vanadium	45	46							
Zinc	77	59	155	67.2 E	103.2 E	44.1 E	66.2 E	114.1 E	117
PAHs									
Acenaphthene	0.0067 U	0.0067 U	0.003	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.00072
Acenaphthylene	0.0067 U	0.0067 U	0.00038 J	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.00065 U
Anthracene	0.2	0.0067 U	0.0027	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0012
Benzo(a)anthracene	0.073	0.0067 U	0.037	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0053
Benzo(a)pyrene	0.014	0.0067 U	0.035	0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	0.0048
Benzo(b)fluoranthene	0.065	0.0067 U		0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	
Benzo(g,h,i)perylene	0.011	0.0067 U	0.022	0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	0.0033 U/B
Benzo(k)fluoranthene	0.021	0.0067 U		0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	
Chrysene	0.11	0.0067 U	0.050	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0065
Dibenzo(a,h)anthracene	0.0067 U	0.0067 U	0.0097 J	0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	0.0015
Fluoranthene	0.3	0.0067 U	0.0390	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0085
Fluorene	0.015	0.0067 U	0.0025	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.00086
Indeno(1,2,3-cd)pyrene	0.011	0.0067 U	0.0240	0.084 U	0.084 U	0.084 U	0.080 U	0.092 U	0.0045 U/B
Naphthalene	0.0067 U	0.0067 U	0.0022	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0010
Phenanthrene	0.074	0.0067 U	0.019	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0068
Pyrene	0.2	0.0067 U	0.047	0.042 U	0.042 U	0.042 U	0.040 U	0.046 U	0.0087
PCBs									
Aroclor 1016	0.05 U	0.05 U		0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	
Aroclor 1242/1016			0.010 U						0.10 U
Aroclor 1221	0.1 U	0.1 U	0.020 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.02 U
Aroclor 1232	0.05 U	0.05 U	0.010 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.01 U
Aroclor 1242	0.05 U	0.05 U		0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	
Aroclor 1248	0.05 U	0.05 U	0.010 U/E	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.010 U
Aroclor 1254	0.05 U	0.05 U	0.010 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.010 U
Aroclor 1260	0.05 U	0.05 U	0.010 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.010 U
Total PCBs			0.070 U						0.070 U
TPH (mg/L)									
TPH (418.1)	20 U	20 U							

E = Estimated Value.

R = Rejected data.

U = Compound was not detected. Value is the lower quantification limit.

U/B = Compound was not detected due to blank contamination.

a = Source: Reconnaissance Survey of the Lower Columbia River (Tetra Tech, January 1993)

b = Source: Lower Columbia River Backwater Reconnaissance Survey (Tetra Tech, May 1994)

c = Source: Draft Current Situation Summary (CH2M HILL, April 1996)

Table A4
Background Data for Sandy River Sediment

Station ID	SR-SD34 ^a	SR-SD35 ^a	SR-SD36 ^a	SR-SD37 ^a	SD-27 ^b
Location Description	Between Railroad and I-84	North of I-84, East of Airport	South of Railroad	North of I-84, Downstream of WWTP	South of Railroad
Date Sampled	6/24/96	6/24/96	6/24/96	6/24/96	5/19/93
Analyte					
Cyanide, Total	1 U	1 U	1 U	1 U	3.3 U
Fluoride (340.1/2)	160	120	140	130	119
Fluoride (340.2 M)	2.5 U	2.5 U	2.5 U	2.5 U	
TOC	750	1400	2650	669	
Metals					
Aluminum	5890	5650	8390	6370	3890 J
Antimony	2.5 U	2.5 U	2.5 U	2.5 U	7.2 UJ
Arsenic	0.51	0.75	0.88	1.8	0.42 U
Barium	14.8	22.8	32.9	19.7	8 B
Beryllium	0.5 U	0.5 U	0.5 U	0.5 U	0.61 B
Cadmium	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	3450	2800	2900	3280	2850 J
Chromium	7.76	10.9	14.7	10.7	12.5
Cobalt	3.22	3.79	4.85	4.1	7.5 B
Copper	11	10.4	12.2	15.2	10.5 J
Iron	8810	10400	13100	11200	11500 J
Lead	5 U	5 U	5 U	5 U	0.26 BJ
Magnesium	1370	1800	1810	1650	1450 J
Manganese	150	113	156	120	103 J
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.1 UJ
Nickel	7.13	9.29	11.2	9.11	10 B
Potassium	190	231	247	242	67 U
Selenium	1 U	1 U	1 U	1 U	0.42 R
Silver	1 U	1 U	1 U	1 U	0.4 U
Sodium	918	565	577	715	504 J
Thallium	1 U	1 U	1 U	1 U	0.21 U
Vanadium	31.4	38.2	44.2	39.2	46.8 J
Zinc	17.1	21.3	28.1	38.4	32.9 J
PAHs					
Acenaphthene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Acenaphthylene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Benzo(a)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Benzo(a)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Benzo(b)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Benzo(g,h,i)perylene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Benzo(k)fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Chrysene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Dibenzo(a,h)anthracene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Fluoranthene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Fluorene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Indeno(1,2,3-cd)pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Naphthalene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Phenanthrene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
Pyrene	0.3 U	0.3 U	0.3 U	0.3 U	0.45 U
PCBs					
Total PCBs	0.3 U	0.3 U	0.3 U	0.3 U	

U = Substance was not detected. Value given is lower quantification limit.

J = Estimated value.

R = Rejected data.

B = Below reporting limit and above instrument detection limit.

a = Source: Supplemental Background Data-Gathering

b = Source: Final Site Inspection Report (PRC, October 1993)

Table A5
Background Data for Salmon Creek Sediment

Station ID	Salmon Creek					Fairview Creek					
	WD-SD32 ^a	WD-SD33 ^a	RM-SD11 ^a	WD-SD29 ^b	WD-SD26 ^a	RFGS014000 ^c	RFGS014001 ^c	RFGS027000 ^c	RFGS034000 ^c	RFGS044000 ^c	RFGS051000 ^c
Location Description	Upstream of Troutdale Airport	Upstream of I-84	North Side of Graham Road	North Side of Graham Road	Upstream of West Drainage	Upstream of culvert crossing	Upstream of culvert crossing	Downstream of railroad crossing	Downstream of overhead power lines	Downstream of Blue Lake Road	Upstream of railroad crossing
Date Sampled	7/2/96	7/2/96	8/19/94	2/23/95	2/22/95	10/5/95	10/5/95	10/5/95	10/6/95	10/6/95	10/6/95
Analyte (mg/kg)											
Cyanide, Total	1 U	1 U	0.5 U	0.067 U	0.043 U	0.21 U	0.21 U	0.025 U	0.022 U	0.48 U	0.41 U
Fluoride (340.1/2)	250	160									
Fluoride (340.2M)			5 U								
TOC	8100	13800	25000	18000	4400	16000	14000	20000	26000	29000	26000
Metals											
Aluminum	8270	10300	13000	13000	7600	15400	15300	17200	20400	20000	25100
Antimony	2.5 U	2.5 U	0.5 U	1.3 U	1.3 U	0.09 U	0.09 U	0.6 U	0.08 U	0.1 U	0.1 U
Arsenic	1.7	2.7	2.1	3.1	1 U	1.7	1.9	2.8	6.5	2.4	5.0
Barium	39.3	63.3	72 L	92	26	95.9	94.2	105	128	128	203
Beryllium	0.5 U	0.5 U	0.2 U	1 U	1 U	0.36	0.32	0.40	0.47	0.40	0.60
Cadmium	0.5 U	0.5 U	0.2 U	1 U	1 U	0.3	0.2	0.4	0.3	0.5	0.3
Calcium	3460	3660	5200	4000 L	3200						
Chromium	11.7	17	14	23	12	22.4	20.8	23.1	32	26.7	39.9
Cobalt	4.71	7.78	13	15	8.1	7.8	7.3	8.8	13.4	10.6	11.9
Copper	12.1	14	16	31	55 J	16.6	16.5	18.7	18.8	20.5	23.8
Iron	13300	21300	24000	25000	11000	19000	19000	22300	24900	26100	30700
Lead	10.8	16.2	16	31	10 U	22	21	31	29	34	49
Magnesium	1900	3330	2700	2700 L	1400						
Manganese	120	268	360	170 L	76	189	185	258	236	563	495
Mercury	0.2 U	0.2 U	0.042 U	0.14 U	0.2 U	0.03	0.03	0.04	0.04	0.04	0.06
Nickel	9.62	13	12	15	11	15.2	12.8	15	20.8	17	21
Potassium	533	866	600	710	480						
Selenium	1 U	1 U	0.2 UL	1 U	1 U	0.18	0.20	0.6 U	0.40	0.20	0.6 U
Silver	1 U	1 U	0.2 U	1 U	1 U	0.04	0.03	0.2 U	0.04	0.05	0.05
Sodium	693	374	600	690	340						
Thallium	1 U	1 U	0.2 U	1 U	1 U	0.09 U	0.1 U	0.1 U	0.4 U	0.5 U	0.6 U
Vanadium	41.4	57.8	64 L	83 L	58	49.4	49.5	59.7	71.3	71.1	82.2
Zinc	62.3	74.3	130 L	200	69	110	107	137	85	187	137
PAHs											
Acenaphthene	0.3 U	0.3 U	0.034 U	0.034 U	0.034 U						
Acenaphthylene	0.3 U	0.3 U	0.034 U	0.034 U	0.034 U						
Anthracene	0.3 U	0.3 U	0.034 U	0.034 U	0.077	0.035 U	0.035 U	0.04 U	0.034 U	0.037 J	0.04 U
Benzo(a)anthracene	0.3 U	0.3 U	0.034 U	0.085	0.44	0.016	0.013	0.023 J	0.0081	0.062	0.028
Benzo(a)pyrene	0.3 U	0.3 U	0.034 U	0.14	0.53	0.025	0.019	0.037 J	0.014	0.073	0.05
Benzo(b)fluoranthene	0.3 U	0.3 U	0.22	0.29	0.84	0.044	0.026	0.059 J	0.018	0.11	0.11
Benzo(g,h,i)perylene	0.3 U	0.3 U	0.18	0.12 J	0.4						
Benzo(k)fluoranthene	0.3 U	0.3 U	0.034 U	0.092	0.24	0.023	0.018	0.036	0.013 J	0.067	0.056
Chrysene	0.3 U	0.3 U	0.034 U	0.17	0.52						
Dibenzo(a,h)anthracene	0.3 U	0.3 U	0.034 U	0.034 U	0.097	0.0042	0.0039	0.0081 J	0.0027	0.012	0.0083
Fluoranthene	0.3 U	0.3 U	0.034 U	0.19	0.68						
Fluorene	0.3 U	0.3 U	0.034 U	0.034 U	0.034 U						
Indeno(1,2,3-cd)pyrene	0.3 U	0.3 U	0.16	0.1	0.32	0.026	0.024	0.027 J	0.014 JM	0.045 M	0.01
Naphthalene	0.3 U	0.3 U	0.034 U	0.034 U	0.034 U						
Phenanthrene	0.3 U	0.3 U	0.034 U	0.085	0.34	0.022	0.015	0.027	0.014 J	0.13	0.018
Pyrene	0.3 U	0.3 U	0.14	0.21	0.58	0.045	0.038	0.065	0.024	0.13	0.1

Table A5
Background Data for Salmon Creek Sediment

Station ID	Salmon Creek					Fairview Creek					
	WD-SD32 ^a	WD-SD33 ^a	RM-SD11 ^a	WD-SD29 ^a	WD-SD26 ^a	RFGS014000 ^c	RFGS014001 ^c	RFGS027000 ^c	RFGS034000 ^c	RFGS044000 ^c	RFGS051000 ^c
Location Description	Upstream of Troutdale Airport	Upstream of I-84	North Side of Graham Road	North Side of Graham Road	Upstream of West Drainage	Upstream of culvert crossing	Upstream of culvert crossing	Downstream of railroad crossing	Downstream of overhead power lines	Downstream of Blue Lake Road	Upstream of railroad crossing
Date Sampled	7/2/96	7/2/96	8/19/94	2/23/95	2/22/95	10/5/95	10/5/95	10/5/95	10/6/95	10/6/95	10/6/95
Analyte (mg/kg)											
PCBs											
Aroclor 1016			0.05 U	0.05 U	0.05 U	0.098 U	0.098 U	0.12 U	0.096 U	0.12 Uuj	0.12 U
Aroclor 1221			0.1 U	0.1 U	0.1 U	0.12 U	0.12 U	0.14 U	0.11 U	0.14 Uuj	0.14 U
Aroclor 1232			0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.06 U	0.049 U	0.06 Uuj	0.06 U
Aroclor 1242			0.05 U	0.05 U	0.05 U						
Aroclor 1248			0.05 U	0.05 U	0.05 U	0.039 U	0.039 U	0.47 U	0.038 U	0.046 Uuj	0.047 U
Aroclor 1254			0.05 U	0.05 U	0.12	0.12 U	0.12 U	0.14 U	0.12 U	0.14 Uuj	0.14 U
Aroclor 1260			0.05 U	0.05 U	0.05 U	0.096 U	0.096 U	0.11 U	0.094 U	0.11 Uuj	0.12 U
Total PCBs	0.3 U	0.3 U									
TPH											
Gasoline (Method TPH-G)			2 U								
Diesel (Method TPH-D)			170								
Heavy/Bunker (Method TPH418 1-M)			290								
Gasoline (Method TPH-HCID)				20 U	100 U						
Diesel (Method TPH-HCID)				50 U	280 ^d						
Heavy/Bunker (Method TPH-HCID)				100 U	1200 ^d						

U = Substance was not detected. Value given is lower quantification limit

J = Estimated value

L = Estimated value, may be low on basis of spike recovery

M = Estimated value, analyte found but with low spectral match

j = Positive identification but below sample detection limit

uj = Analyte was not detected and reported quantitation is considered an estimate

a = Source: Supplemental Background Data-Gathering

b = Source: Draft Current Situation Summary (CH2M HILL, April 1996)

c = Source: Focused Remedial Investigation Report for Buffalo Slough and Reference Sites (Parametrix, May 1996)

d = Oregon DEQ TPH-HCID is a screening method. Any results above detection limit are estimated values.

Table A6
Background Data for Columbia River Surface Water

Station ID	RM-SW1 ^a	W42-T ^b	Station 14 ^c	W43 ^b	W44 ^b	Station 15 ^c	W45-T ^b
River Mile	RM 123	RM 123.5	RM124	RM 128.5	RM141	RM141	RM146
Date Sampled	8/18/94	9/25/91	7/1/93	9/24/91	9/26/91	6/30/93	9/26/91
Analyte (mg/L)							
Cyanide	0.01 U	0.002 U/E	0.002 U	0.002 U/E	0.002 U/E	0.002 U	0.002 U/E
Fluoride	0.5 U	0.5 U		0.5 U	0.5 U		0.5 U
Hardness	57	57	51.3	53	57	59.9	62
Total Metals							
Aluminum	0.1 U	1.100 E	0.443 E	1.300 E	0.250 U/E	0.445	0.270 U/E
Antimony	0.005 U	0.015 U/E	0.003 U	0.150 U/E	0.015 U/E	0.003 U	0.015 U/E
Arsenic	0.004 U	0.005 U/E	0.003 U	0.005 U/E	0.005 U/E	0.003 U	0.005 U/E
Barium	0.02 U	0.032 E	0.020	0.022 E	0.027 E	0.021	0.028 E
Beryllium	0.02 U	0.005 U/E	0.002 U/E	0.005 U/E	0.005 U/E	0.002 U/E	0.005 U/E
Cadmium	0.0003 U	0.0005 U/E	0.0001 U	0.0005 U/E	0.0005 U/E	0.00004 U/B	0.0005 U/E
Calcium	15						
Chromium	0.02 U	0.005 U/E	0.001 U	0.005 U/E	0.005 U/E	0.001 U	0.005 U/E
Cobalt	0.05 U						
Copper	0.02 U	0.005 U/E	0.0031 U/B	0.005 E	0.005 U/E	0.0026	0.005 U/E
Iron	0.1 U	1.300 E	0.657	1.800 E	0.320 U/E	0.468	0.310 U/E
Lead	0.004 U	0.001 U/E	0.0011	0.001 U/E	0.001 U/E	0.0015	0.001 U/E
Magnesium	0.02 U						
Manganese	4.7						
Mercury	0.0005 U	0.0005 U/E	0.00011 U	0.0005 U/E	0.0005 U/E	0.00011 U	0.0005 U/E
Nickel	0.05 U	0.040 U/E	0.005 U	0.040 U/E	0.040 U/E	0.005 U	0.040 U/E
Potassium	1						
Selenium	0.004 U	0.005 U/E	0.003 U	0.005 U/E	0.005 U/E	0.003 U	0.005 U/E
Silver	0.02 U	0.002 U/E	0.001 U	0.002 U/E	0.002 U/E	0.001 U	0.002 U/E
Sodium	6.2						
Thallium	0.004 U	0.036 U/E	0.001 U	0.360 U/E	0.036 U/E	0.001 U	0.036 U/E
Vanadium	0.02 U						
Zinc	0.05 U	0.077 E	0.013 E	0.020 U/E	0.020 U/E	0.005 E	0.020 U/E
PAHs							
Acenaphthene	0.005 U						0.002 U
Acenaphthylene	0.005 U						0.002 U
Anthracene	0.005 U						0.002 U
Benzo(a)anthracene	0.0001 U						0.002 U
Benzo(b)fluoranthene	0.0001 U						0.004 U
Benzo(k)fluoranthene	0.0001 U						0.004 U
Benzo(a)pyrene	0.0001 U						0.004 U
Benzo(g,h,i)perylene	0.0001 U						0.004 U
Chrysene	0.0001 U						0.002 U
Dibenzo(a,h)anthracene	0.0001 U						0.004 U
Fluoranthene	0.0001 U						0.002 U
Fluorene	0.005 U						0.002 U
Indeno(1,2,3-cd)pyrene	0.0001 U						0.004 U
Naphthalene	0.005 U						0.002 U
Phenanthrene	0.005 U						0.002 U
Pyrene	0.0005 U						0.002 U
PCBs							
Aroclor 1016	0.001 U						0.0005 U
Aroclor 1221	0.002 U						0.0005 U
Aroclor 1232	0.001 U						0.0005 U
Aroclor 1242	0.001 U						0.0005 U
Aroclor 1248	0.001 U						0.0005 U
Aroclor 1254	0.001 U						0.0005 U
Aroclor 1260	0.001 U						0.0005 U
TPH (mg/L)							
Gasoline	0.2 U						
Diesel/related (C12-C24)	0.5 U						
Heavy oil/related (C24-C)	1 U						

U = Compound was not detected. Value is the lower quantification limit.

E = Estimated value.

U/B = Compound was not detected due to blank contamination.

a = Source: Draft Current Situation Summary (CH2M HILL, April 1996)

b = Source: Reconnaissance Survey of the Lower Columbia River (Tetra Tech, January 1993)

c = Source: Lower Columbia River Backwater Reconnaissance Survey (Tetra Tech, May 1994)

Table A7
Background Data for Sandy River Surface Water

Station ID	SR-SW34 ^a	SR-SW35 ^a	SW-08 ^b
Location Description	Between Railroad and I-84	North of I-84, East of Airport	South of Railroad
Date Sampled	6/24/96	6/24/96	5/19/93
Analyte (mg/L)			
Cyanide, Total	0.02 U	0.02 U	0.01 U
Fluoride	0.25 U	0.25 U	0.1 U
Hardness	18.7	18.7	
Total Metals			
Aluminum	0.13	0.15	0.0895
Antimony	0.005 U	0.005 U	0.0287 U
Arsenic	0.004 U	0.004 U	0.0011 U
Barium	0.02 U	0.02 U	0.0051 U
Beryllium	0.0003 U	0.0003 U	0.0018 U
Cadmium	0.002 U	0.002 U	0.002 U
Calcium	4.63	4.62	3.33
Chromium	0.01 U	0.01 U	0.005 U
Cobalt	0.05 U	0.05 U	0.0104 U
Copper	0.002 U	0.002 U	0.0022 U
Iron	0.156	0.157	0.136 U
Lead	0.001 U	0.0011	0.001 UJ
Magnesium	1.73	1.73	1.18
Manganese	0.02 U	0.02 U	0.0047
Mercury	0.0002 U	0.0002 U	0.0002 U
Nickel	0.04 U	0.04 U	0.0153 U
Potassium	1 U	1 U	0.537 U
Selenium	0.005 U	0.005 U	0.0016 R
Silver	0.003 U	0.003 U	0.0016 U
Sodium	3.7	3.91	2.46
Thallium	0.002 U	0.002 U	0.0008 UJ
Vanadium	0.02 U	0.02 U	0.0047 U
Zinc	0.05 U	0.05 U	0.0524 U
PAHs			
Acenaphthene	0.0001 U	0.0001 U	0.01 U
Acenaphthylene	0.0001 U	0.0001 U	0.01 U
Anthracene	0.0001 U	0.0001 U	0.01 U
Benzo(a)anthracene	0.0001 U	0.0001 U	0.01 U
Benzo(a)pyrene	0.0001 U	0.0001 U	0.01 U
Benzo(b)fluoranthene	0.0001 U	0.0001 U	0.01 U
Benzo(g,h,i)perylene	0.0001 U	0.0001 U	0.01 U
Benzo(k)fluoranthene	0.0001 U	0.0001 U	0.01 U
Chrysene	0.0001 U	0.0001 U	0.01 U
Dibenz(a,h)anthracene	0.0001 U	0.0001 U	0.01 U
Fluoranthene	0.0001 U	0.0001 U	0.01 U
Fluorene	0.0001 U	0.0001 U	0.01 U
Indeno(1,2,3-cd)pyrene	0.0001 U	0.0001 U	0.01 U
Naphthalene	0.0001 U	0.0001 U	0.01 U
Phenanthrene	0.0001 U	0.0001 U	0.01 U
Pyrene	0.0001 U	0.0001 U	0.01 U
PCBs			
Aroclor 1016			0.001 U
Aroclor 1221			0.002 U
Aroclor 1232			0.001 U
Aroclor 1242			0.001 U
Aroclor 1248			0.001 U
Aroclor 1254			0.001 U
Aroclor 1260			0.001 U
Total PCBs	0.001 U	0.001 U	
U = Estimated value R = Rejected data U = Substance was not detected. Value given is lower quantification limit a = Source: Supplemental Background Data Gathering b = Source: Final Site Inspection Report (PRC, October 1993)			

Table A8
Background Data for Salmon Creek Surface Water

Station ID	WD-SW32 ^a	WD-SW33 ^a	RM-SW11 ^b	WD-SW29 ^b	WD-SW26 ^b
Location Description	Upstream of Troutdale Airport	Upstream of I-84	North Side of Graham Road	South Side of Graham Road	Upstream of West Drainage
Date Sampled	7/2/96	7/2/96	8/18/94	2/23/95	2/22/95
Analyte (mg/L)					
Cyanide, Total	0.02 U	0.02 U	0.01 U	0.01 U	0.01 U
Fluoride	0.25 U	0.25 U	0.5 U	0.5 U	0.5 U
Hardness	62.7	63.1	57		
Total Metals					
Aluminum	0.05 U	0.05 U	0.1	0.1 U	0.14
Antimony	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Arsenic	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
Barium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Beryllium	0.0003 U	0.0003 U	0.02 U	0.02 U	0.02 U
Cadmium	0.002 U	0.02 U	0.0003 U	0.0003 U	0.0003 U
Calcium	15.3	15.3	13	15 *	15
Chromium	0.01 U	0.01 U	0.02 U	0.02 U	0.02 U
Cobalt	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Copper	0.002 U	0.002 U	0.02 U	0.02 U	0.02 U
Iron	0.23	0.169	0.17	0.6	0.63
Lead	0.001 U	0.001 U	0.004 U	0.004 U	0.004 U
Magnesium	5.96	6.04	6	5.6	6.2
Manganese	0.0351	0.0271	0.02 U	0.05	0.058
Mercury	0.0002 U	0.0002 U	0.0005 U	0.0005 U	0.0005 U
Nickel	0.04 U	0.04 U	0.05 U	0.05 U	0.05 U
Potassium	3	3.01	2.3	2.7	3.1
Selenium	0.005 U	0.005 U	0.004 U	0.004 U	0.004 U
Silver	0.003 U	0.003 U	0.02 U	0.02 U	0.02 U
Sodium	7.01	6.68	5.8	7.6	7.2
Thallium	0.002 U	0.002 U	0.004 U	0.004 U	0.004 U
Vanadium	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Zinc	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PAHs					
Acenaphthene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Acenaphthylene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Anthracene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Benzo(a)anthracene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(a)pyrene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(b)fluoranthene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(g,h,i)perylene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(k)fluoranthene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Chrysene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Dibenz(a,h)anthracene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluoranthene	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluorene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Indeno(1,2,3-cd)pyrene	0.0001 U	0.0001 U	0.0001 U	0.0002 U	0.0002 U
Naphthalene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Phenanthrene	0.0001 U	0.0001 U	0.005 U	0.0001 U	0.0001 U
Pyrene	0.0001 U	0.0001 U	0.0005 U	0.0001 U	0.00013
PCBs					
Aroclor 1016			0.001 U	0.0005 U	0.0005 U
Aroclor 1221			0.002 U	0.001 U	0.001 U
Aroclor 1232			0.001 U	0.0005 U	0.0005 U
Aroclor 1242			0.001 U	0.0005 U	0.0005 U
Aroclor 1248			0.001 U	0.0005 U	0.0005 U
Aroclor 1254			0.001 U	0.0005 U	0.0005 U
Aroclor 1260			0.001 U	0.0005 U	0.0005 U
Total PCBs	0.001 U	0.001 U			
TPHs					
Gasoline			0.2 U	0.08 U	0.08 U
Diesel/related (C12-C24)			0.5 U	0.28	0.3 U
Heavy oil/related (C24-C40)			1 U	0.5 U	0.6 U

U = Substance was not detected. Value given is lower quantification limit.

^a = Source: Supplemental Background Data-Gathering

^b = Source: Draft Current Situation Summary (CH2M HILL, April 1996)

Table A9
Background Data for Columbia River Fish Tissue

River Mile: Sample ID:	RM 120 ^a 13-1-LS	RM 120 ^a 13-2-LS	RM 120 ^a 13-3-LS	RM 124 ^a 14-LS	RM 125.5 ^a D38	RM 141.5 ^a D40	RM 125.5 ^a D38	RM 141 ^a 15-C	RM 141.1 ^a D40	RM 127 ^a	RM 136 ^a
Fish Type	Large Scale Sucker	Large Scale Sucker	Large Scale Sucker	Large Scale Sucker	Large Scale Sucker	Large Scale Sucker	Carp	Carp	Carp	White Sturgeon	White Sturgeon
Tissue Type	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Whole Body Composite- 5 individuals	Filet-20 individuals	Filet-20 individuals
Percent Lipid	1.4	1	3	2.2	3.25	3.73	3.29	3	4.02	0.91	1.8
Analyte	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.	Norm. ^a Conc.
Total Metals (mg/kg)											
Antimony	0.012 U	0.012 U	0.011 U	0.011 U	0.31 U/E	0.32 U/E	0.36 U/E	0.012 U	0.44 U/E	2.4 U	2.2 U
Arsenic	0.035 U	0.036 U	0.034 U	0.034 U	0.42 U	0.43 U	0.49 U	0.035 U	0.58 U	0.27	0.84
Barium	3.2	3.1	3.5	3.5	3.6 E	3.7 E	3.4 E	1.2	1.3 E	0.1 U/E	0.1 U/E
Cadmium	0.066	0.059	0.053	0.062	0.04	0.06	0.29	0.039	0.12 E	0.02 U	0.02 U
Chromium	0.314	0.325	0.527	0.45				0.078			
Copper	1.16	1.23	1.18	1.21	0.75 E	0.75 E	1.68 E	1.26	1.51 E	0.48 U/E	0.5 E
Lead	0.183 E	0.376 E	0.296 E	0.009 U	0.41 E	0.17 E	0.22 E	0.116 E	0.23 E	0.02 E	0.04 E
Mercury	0.215	0.161	0.119	0.196	0.051 E	0.131 E	0.129 E	0.001 U	0.104 E	0.061 E	0.076 E
Nickel	0.1 U	0.28	2.26	0.13	0.73 U/E	0.75 U/E	17.29 E	0.1 U	1.02 U/E	0.56 U/E	0.59 E
Selenium	0.035 U	0.036 U	0.034 U	0.034 U	0.42 U	0.43 U	0.49 U	0.035 U	0.58 U	0.32 U	0.29 U
Silver	0.004 U/E	0.004 U/E	0.004 U/E	0.004 U/E	0.19 U/E	0.19 U/E	0.22 U/E	0.005 E	0.26 U/E	0.14 U/E	0.13 U/E
Zinc	20.7 E	22.4 E	13.7 E	23.7 E	22.9 E	23.7 E	109.6 E	92.1 E	89.9 E	3.8 E	4.2 E
PAHs (ug/kg)											
Acenaphthene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Acenaphthylene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Anthracene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Benzo(a)anthracene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Benzo(b)fluoranthene					200 U	200 U	200 U		200 U	200 U	200 U
Benzo(k)fluoranthene					200 U	200 U	200 U		200 U	200 U	200 U
Benzo(a)pyrene	9.6 U	8.5 U	9.8 U	9.9 U	200 U	200 U	200 U	10 U	200 U	200 U	200 U
Benzo(g,h,i)perylene	9.6 U	8.5 U	9.8 U	9.9 U	200 U	200 U	200 U	10 U	200 U	200 U	200 U
Chrysene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Dibenzo(a,h)anthracene	9.6 U	8.5 U	9.8 U	9.9 U	200 U	200 U	200 U	10 U	200 U	200 U	200 U
Flouranthene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Flourene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U	100 U	10 U	100 U	100 U	100 U
Indeno(1,2,3-cd)pyrene	9.6 U	8.5 U	9.8 U	9.9 U	200 U	200 U		10 U		200 U	200 U
Naphthalene	9.6 U	8.5 U	6.6 0.2 J	9.9 U	100 U	100 U		10 U		100 U	100 U
Phenanthrene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U		10 U		100 U	100 U
Pyrene	9.6 U	8.5 U	9.8 U	9.9 U	100 U	100 U		10 U		100 U	100 U
PCBs (ug/kg)											
Aroclor 1221	52 U	52 U	52 U	52 U	50 U	50 U	50 U	52 U	50 U	50 U	50 U
Aroclor 1232	56 4	52 U	37 1.2 J	52 U	50 U	50 U	50 U	52 U	50 U	50 U	50 U
Aroclor 1242/1016	52 U	52 U	52 U	52 U	50 U	50 U	50 U	52 U	50 U	50 U	50 U
Aroclor 1248	52 U	52 U	52 U	52 U	50 U	50 U	50 U	52 U	50 U	50 U	50 U
Aroclor 1254	68 4.9	26 2.6 J	170 5.7	38 1.7 J	130 4	50 U	110 3.3	36 1.2 J	50 U	50 U	50 U
Aroclor 1260	56 4	52 U	37 1.2 J	52 U	50 U	130 3.5	50 U	52 U	110 2.7	50 U	50 U
Total PCBs	124 8.9	26 2.6 J	207 6.9	38 1.7 J	130 4	130 3.5	110 3.3	36 1.2 J	110 2.7	0	0

Values in bold are greater than the detection limit

^a = Lipid-normalized data, in ug/g, only presented when a compound is detected Metals were not lipid normalized

E = Estimated value based on evaluation of QC data

U = Estimated value less than specified detection limit

U = Substance was not detected Value given is lower quantification limit

^a = Source: Lower Columbia River Backwater Reconnaissance Survey (Tetra Tech, May 1994)

^b = Source: Reconnaissance Survey of the Lower Columbia River (Tetra Tech, January 1993)